U.S. FISH AND WILDLIFE SERVICE

Draft Post-Delisting Monitoring Plan for the Louisiana Black Bear (*Ursus americanus luteolus*)

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Anti-deficiency Act Disclaimer

Post-delisting monitoring is a cooperative effort between the U.S. Fish and Wildlife Service, State and Tribal governments; other Federal agencies, and nongovernmental partners. Funding of post-delisting monitoring presents a challenge for all partners committed to ensuring the continued viability of the Louisiana black bear following removal of protections afforded under the Endangered Species Act, as amended. To the extent feasible, the Service and our partners intend to provide funding for post-delisting monitoring efforts through the annual appropriations process. Nonetheless, nothing in this Post-Delisting Monitoring Plan should be construed as a commitment or requirement that any Federal agency obligate or pay funds in contravention of the Anti-Deficiency Act, 31 U.S.C. 1341, or any other law or regulation.

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I. Introduction

Post-delisting monitoring refers to activities undertaken to verify that a species delisted due to recovery remains secure from risk of extinction after the protections of the Endangered Species Act (Act; 16 U.S.C. 1531 *et seq*.) are no longer applicable. A primary goal of post-delisting monitoring is to monitor the species to ensure the status does not deteriorate, and if a substantial decline in the species (numbers of individuals or populations) or an increase in threats is identified, to enact measures to halt the decline so that re-proposing the species as threatened or endangered is not needed.

Section 4(g)(1) of the Act requires the Secretary of the Interior to implement a system in cooperation with the States to monitor effectively, for not less than 5 years the status of all species that have recovered and been removed from the Federal List of Endangered and Threatened Wildlife and Plants (List). Section 4(g)(2) of the Act directs the U.S. Fish and Wildlife Service (Service) to make prompt use of its emergency listing authorities under section 4(b)(7) to prevent significant risk to the well-being of any recovered species. While not specifically mentioned in section 4(g), authorities to list species in accordance with the process prescribed in sections 4(b)(5) and 4(b)(6) may also be utilized to reinstate species on the List, if warranted.

The Service and States have latitude to determine the extent and intensity of post-delisting monitoring that is needed and appropriate. The Act does not require the development of a formal Post-Delisting Monitoring Plan (PDM). However, we generally desire to follow a written planning document to provide for the effective implementation of section 4(g) by guiding collection and evaluation of pertinent information over the monitoring period and articulating the associated funding needs. This document was prepared to describe the post-delisting monitoring for the Louisiana black bear (*Ursus americanus luteolus*) and follows the Service's August 2008, *Post-Delisting Monitoring Plan Guidance Under the Endangered Species Act*.

II. Species Listing History

The Louisiana black bear (LBB) was included as a category 2 species in the notice of review published on December 30, 1982 (47 FR 58454), September 18, 1985 (50 FR 58454) and January 6, 1989 (54 FR 554). On March 6, 1987, the Service was petitioned to list the LBB as an endangered species. The Service made two, 12-month findings (August 19, 1988, 53 FR 31723 and August 10, 1989, 54 FR 32833) indicating that listing may be warranted but was precluded by other actions. On June 21, 1990, the Service proposed listing the LBB as a threatened species (55 FR 25341). The LBB was listed as a threatened species under the Act on January 7, 1992, due to historical habitat loss and fragmentation as well as the ongoing threats of continued habitat modification and human-related mortality (57 FR 588). The recovery plan was finalized on September 1995 (USFWS 1995). The Service first proposed critical habitat for the LBB on December 2, 1993 (58 FR 63560), but never published a final rule designating critical habitat. On May 6, 2008, we announced our withdrawal of the 1993 proposal and proposed LBB critical habitat designation (73 FR 25354). On March 10, 2009, we designated critical habitat (74 FR 10350). The five-year review was completed in October 2014 (USFWS 2014). On

<DATE>, the Service published a proposed rule to remove the LBB from the List of Threatened and Endangered Wildlife (50 CFR 17.11 and 17.12) due to recovery.

III. Summary of Cooperator Roles in the Post-Delisting Monitoring Planning Effort

The Service prepared this draft PDM in coordination with the Louisiana Department of Wildlife and Fisheries (LDWF). This plan is designed to detect significant declines in Louisiana black bear populations with reasonable certainty and precision. It meets the minimum requirement set forth by the Act by effectively monitoring the status of Louisiana black bear using annual population sampling events and regular monitoring of habitat trends. The primary goal of this plan will be accomplished through cooperation with the LDWF, other U.S. Federal agencies, non-governmental organizations, and individuals.

U.S. Fish and Wildlife Service

The Service is responsible for ensuring that effective post-delisting monitoring of the Louisiana black bear is accomplished through participation and maintaining oversight of all activities implemented with the LDWF and their cooperators. Participation includes regular coordination with the LDWF on the results of their post-delisting monitoring and management plan activities and incorporation and analysis by the Service of additional information on habitat trends (as it regularly becomes available during the monitoring period) that may aid in assessing the status of Louisiana black bear.

Louisiana Department of Wildlife and Fisheries

The LDWF will be responsible for collecting Louisiana black bear population and demographic data. The LDWF and their partners (University of Tennessee [UT] and the USGS Southern Appalachian Research Station [USGS]) have been the principal parties monitoring the recovery of this species. They have been conducting Louisiana black bear population studies since 2006, 2007, and 2011, in the Tensas River Basin (TRB), Upper Atchafalaya River Basin (UARB), and Lower Atchafalaya River Basin (LARB), primarily using non-invasive mark-recapture studies based on collection and genotyping of hair samples. This PDM will build directly upon the previous population monitoring methods and data used during recovery as described in Laufenberg and Clark (2014, pp.7-20).

IV. Summary of Species Status at Time of Delisting

A. Background

The Louisiana black bear is a subspecies of the American black bear (*Ursus americaus*) that historically occurred from eastern Texas, throughout Louisiana, and into southwest Mississippi. There were no precise estimates for the overall Louisiana black bear population at the time of listing. Historically, the species was believed to be common or numerous in bottomland hardwood (BLH) forests, such as the big thicket area of Texas, along the Tensas and Yazoo Rivers in Louisiana and Mississippi, respectively, and the Atchafalaya River Basin in Louisiana

(St. Amant (1959, p. 32; Nowak 1986, p.32). Exploitation of bears due to overharvest and large-scale destruction of forests from the 1700s to the early 1800s resulted in low numbers of bears that were confined to the BLH forests of Madison and Tensas Parishes and the lower Atchafalaya bottomland areas in Louisiana (St. Amant 1959, pp. 32, 44). Black bears in Mississippi were similarly affected (Shropshire 1996, pp. 25-33). By the late 1890s, black bear numbers in East Texas were reduced to scattered remnant populations or were extirpated entirely due to unregulated harvests (Barker et al. 2005, p. 3).

Currently, East Texas remains devoid of a resident breeding subpopulation of the Louisiana black bear, but occasional occurrences of transient males have been documented (Holdermann, D., personal communication, 2014.). Within Louisiana and Mississippi, the subspecies persists in the BLH forests of the Lower Mississippi River Alluvial Valley (LMRAV). Based on the number and distribution of confirmed reports (e.g., sightings, live-capture data, radio-collar data, and mortalities) by LDWF and Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP), the geographic distribution of bears has expanded in those states, and the number and size of resident breeding populations and the habitat they occupy have increased (Davidson et al. 2015, p.22; Simek et al. 2012, p.165). Furthermore, due to habitat restoration and associated subpopulation expansion, lands between the original TRB and UARB subpopulation areas have been recolonized by reproductively active female bears (Figure 1). The Three Rivers Complex (TRC) is an area that contains a new breeding subpopulation (i.e., not present at the time of listing) located at the confluence of the Mississippi and Red Rivers in Louisiana, and formed as a result of a multi-year reintroduction project (2001–2009). Also, 3 additional new breeding subpopulations are naturally establishing in Mississippi adjacent to the TRB and UARB subpopulations (Figure 1; Young 2006, pp. 14-18). Demographic attributes, including subpopulation abundance estimates, growth rates, and adult survival rates have been obtained for the 3 original Louisiana breeding subpopulations (Hooker 2010, pp. 26-27; Laufenberg and Clark, 2014, pp. 76-82; Lowe 2011, pp. 28-30; Troxler 2013, pp. 30-37). Additionally, emigration and immigration (i.e., gene flow) has been documented among several of the Louisiana and Mississippi subpopulations (Laufenberg and Clark 2014, pp.82-85).

<u>Tensas River Basin (TRB) Subpopulation</u>

This breeding subpopulation occurs within the Tensas River Basin (TRB) of Madison and Tensas Parishes, Louisiana, and consists of groups of bears located north (formerly known as the Deltic subpopulation) and south (Tensas River National Wildlife Refuge [NWR] subpopulation) of Interstate 20 that were once believed to be isolated and disjunct from one another (Beausoleil 1999). At the time of listing, no significant movement between the bears on the refuge and private lands to the north had been documented until Anderson (1997, p.82) reported one of the first instances of a bear moving between these two areas. Laufenburg (2014, p.54) found genetic evidence of that historical separation, but radio-collar data and recent genetics data (2006–2012) indicated this subdivision has dissipated, and genetic exchange has occurred at a level substantial enough between these 2 groups to indicate they have assimilated into a singular genetically similar subpopulation. Hooker (2010, p.26) used non-invasive capture mark-recapture methods (CMR) to estimate a combined population (for both genders averaged across years [2006–2008]) of 294 bears (SE = 31) for the combined Tensas River NWR and nearby Deltic and state-owned tracts with an apparent annual survival rate of 0.91 (SE = 0.08), which did not differ by gender. Hooker (2010, p.26) estimated density to be 0.66 bears/km^2 (SE= 0.07).

According to the most recent study (Laufenburg and Clark 2014, p. 31), the estimated mean annual survival rate for radio-collared adult female bears in the TRB subpopulation was 0.99 (95% CI = 0.96-1.00) when data for bears with unknown fates were censored (assumed alive). The estimate was 0.97 (95%CI = 0.93-0.99) when unknown fates were treated as mortalities. To account for the possibility of detection heterogeneity (i.e., capture probability differences among individuals) that is often inherent to bear non-invasive CMR studies (Boulanger et al. 2004, pp. 457-469), Laufenberg and Clark (2014, pp. 18-19) used two models to estimate abundance: Model 1 assumed detection heterogeneity followed a logistic-normal distribution and Model 2 assumed a 2-point finite mixture distribution. We will report results for both models. The current estimated number of female bears from those two models ranged from 133 to 163 (Laufenberg and Clark 2014, p. 39). Assuming a one to one ratio of males to females, and using the most conservative figures, we estimate that the current estimated total population size ranges from 266 to 321 bears.

Estimated mean cub and yearling litter sizes for the TRB subpopulation were 1.85 and 1.40, respectively, and fecundity and yearling recruitment estimates for the TRB were 0.47 and 0.15, respectively (Laufenberg and Clark 2014, p.35). Annual per-capita recruitment estimates ranged from 0.00 to 0.22, and estimates of female apparent survival rates (these included emigration) ranged from 0.87 to 0.93 based on CMR data. The estimated mean of the population growth rate ranged from 0.97 (95% CI = 0.88–1.06) to 1.02 (95% CI = 0.98–1.09), depending on model assumptions, indicating a stable to increasing subpopulation (Laufenberg and Clark 2014, p. 45).

Laufenberg and Clark 2014, pp. 22-24) developed a series of population persistence models to assess the long-term viability of Louisiana black bear subpopulations. Those models were developed using multiple methods to address the treatment of bears with unknown fates. Model 1 used censored fates (assumed alive) and Model 2 assumed mortality. In addition, because uncertainty exists in various model parameters (i.e., variation) that may affect the outcome, three population projections were analyzed for Model 1 and Model 2 resulting in 6 separate population projections (Laufenberg and Clark 2014, pp. 22-23) developed as follows. The first projection accounted for environmental variation for survival and recruitment and also included density dependence (process-only model). Process-only models produced the least conservative (i.e., protective) estimates. The second and third projection models (all-uncertainty projections and the most conservative) included the same sources of variation as the process-only projection, but also included an estimation of uncertainty for survival and recruitment; they differ only in the conservativeness (i.e., worst case scenario for maximum protection of bears, with the 50 percent credible interval being less conservative than the 95 percent credible interval projection). We will report the range of values obtained for all models in the following discussions. Based on CMR estimates from Model 1, the estimated probability of persistence over 100 years for the TRB subpopulation ranged from 1.00 to 0.96 for process-only and all-uncertainty projections, respectively (Laufenberg and Clark 2014, p. 46, Table 4). Similarly, based on the more conservative projections, the probability of persistence was 1.00 and 0.96 based on Model 2 estimates for process-only and all-uncertainty projections (Laufenberg and Clark 2014, p. 46, Table 4).

Early studies suggested that the TRB subpopulation had low genetic diversity (Boersen et al. 2003, p. 204). Recent studies indicate that genetic exchange with other subpopulations has occurred at a level substantial enough to increase genetic diversity at TRB. Genetic analyses show evidence of bear emigration from the White River Basin (WRB) subpopulation of Arkansas into the TRB subpopulation (Laufenberg and Clark 2014, p.63). Based on those analyses, nearly 30 bears in the TRB had a ≥0.10 probability of originating from the WRB subpopulation, 1 had a 0.48 probability of coming from the UARB, and 3 bears were identified as migrants from the WRB (i.e., probability ≥0.99; Laufenberg and Clark 2014, p.63). Additionally, 10 bears sampled in northwestern Mississippi were determined to have a ≥0.90 probability of originating from the TRB. Six bears from northwestern Mississippi (sampled east of the TRB and across the Mississippi River) had mixed ancestry between WRB and TRB. Connectivity modeling analyses by Laufenberg and Clark (2014, p.90) indicated that without the presence of the TRC subpopulation, the potential for dispersal of either sex between TRB and UARB would be low. However, recent LDWF capture records have documented the presence of additional resident breeding females between the TRC and the TRB subpopulations, which may increase the probabilities for interchange (M. Davidson and S. Murphy, LDWF, unpublished data). Laufenberg and Clark (2014, p.100) opined that the establishment of satellite populations of resident breeding bears between subpopulations, as is the case with the TRC, may be a more effective measure to link populations than the establishment of habitat corridors.

Upper Atchafalaya River Basin (UARB) Subpopulation

Nowak (1986) suggested that UARB bear numbers were extremely low or believed to be nonexistent before the introduction of Minnesota bears to Louisiana in the 1960s, but speculated that it consisted of 30 to 40 individuals (based on a LDWF 1981 report). Pelton (1989, p.9) speculated the UARB population size ranged from 30 to 50 bears. Triant et al. (2004, p.653) estimated 41 bears in the UARB population by 1999. Lowe (2011, p.28) estimated a UARB population of 56 bears with an annual survival rate of 0.91 during 2007–2009. More recently, O'Connell-Goode et al. (2014, p. 7) estimated a mean population abundance of 63 bears (2013, p.23) and mean average male and female survivorship to be 0.77 (SE= 0.08) and 0.89 (SE=0.04), respectively. The most recent female population abundance estimate ranged from 25 to 44 (50 to 88 total population of males and females combined), regardless of treatment of capture heterogeneity (Laufenberg and Clark 2014, p.46). Laufenberg and Clark (2014, p.46, Table 4) estimated annual per-capita recruitment was between 0.00 and 0.41, and apparent female survival was between 0.88 and 0.99 during that time period. The estimated mean growth rate ranged from 1.08 (95% CI = 0.93-1.29) to 1.09 (95% CI = 0.90–1.35), indicating a stable to increasing population (Laufenberg and Clark 2014, p.46). The probabilities of the UARB subpopulation persistence over 100 years were greater than 0.99 for both process-only projections for Models 1 and 2, > 0.96 for all uncertainty projections for Model 1, and were lowest for Model 2 all uncertainty projections at 0.93 and 0.849 (50% and 95% credible intervals), respectively (Laufenberg and Clark 2014, p. 46, Table 4).

As discussed previously, Laufenberg and Clark's connectivity models (2014, p.90) indicated there was no potential for dispersal of either sex between the TRB and UARB subpopulations without the current presence of the TRC subpopulation. The potential for natural interchange between UARB and TRC subpopulation is high, and genetics data indicate gene flow has occurred between these 2 subpopulations (Laufenberg and Clark 2014, p.85). A step-selection model predicted that dispersals between the Lower Atchafalaya River Basin (LARB) subpopulation and UARB subpopulation were infrequent but possible for males, but nearly nonexistent for females (Laufenberg and Clark 2014, p.85). Additionally, 3 cubs sampled in west central Mississippi, east of the TRC, showed evidence of mixed ancestry between TRB and UARB bears (Laufenberg and Clark 2014, p. 63). No migrants from the UARB were detected by Laufenberg and Clark (2014, p.85) in the WRB or LARB. Finally, genetic diversity of the UARB subpopulation is the highest among the 3 original Louisiana black bear subpopulations, and second highest of all extant Louisiana subpopulations. Results from Laufenberg and Clark (2014, pp. 53-54) indicated this increase may be the result of the persistence of genetic material from bears sourced from Minnesota during the 1960s.

Lower Atchafalaya River Basin (LARB) Subpopulation

Nowak (1986, p. 7) suggested that there were approximately 30 bears in the LARB subpopulation by 1986. Until recently, the only quantitative estimate for this subpopulation was Triant et al.'s (2004, p.653) population estimate of 77 bears (95% CI = 68–86) during 1999. Similar to their UARB population estimate, the authors felt this may have been an underestimate of the actual number of bears inhabiting the area (Triant et al. 2004, p.655). Troxler (2013, p.30) obtained a population estimate of 138 bears (95% CI = 118.9–157.9) and an estimated growth rate of 1.08, indicating that the subpopulation was increasing. Laufenberg and Clark 's (2014, p.43) recent LARB subpopulation abundance estimate was between 78 and 97 females during 2010–2012 based on Model 1, and between 68 and 84 based on Model 2 (total combined population of 156–194 or 136–168, respectively). Estimates of apparent female survival ranged from 0.81 to 0.84 (Laufenberg and Clark 2014, p.43), possibly due to rates of bear-vehicular collisions (e.g., ~10% annual mortality rate; Troxler 2013, pp. 37-38).

Emigration from this population is limited by poor habitat quality to the north and U.S. Highway 90 serves as an additional barrier to movement. As discussed previously, the potential for interchange between this and other subpopulations is low, predicted dispersals by male bears were infrequent and female dispersal was non-existent, and immigration into this subpopulation has not been documented (Laufenberg and Clark 2014, p.85). Moreover, within this subpopulation, Troxler (2013, p.33) found evidence of an historic genetic bottleneck associated with Highway 317. However, recent data indicate that this has been alleviated and exchange has been occurring across Highway 317 (Troxler 2013, p. 39).

Three Rivers Complex Subpopulation (TRC)

A new breeding subpopulation not present at the time of listing currently exists in Louisiana as a result of translocation efforts (Benson and Chamberlain 2007, pp. 2393-2403; Davidson et al. 2015, pp. 27-28). The subpopulation occurs in the Three Rivers Complex (TRC) located primarily on the Richard K. Yancey Wildlife Management Area (WMA); an area within the historic range of the Louisiana black bear but not known to have resident reproducing females prior to reintroduction efforts. A total of 48 adult female bears and their respective cubs (104 total cubs) were translocated from the TRB subpopulation to the TRC area during 2001–2009 in an attempt to reestablish a resident breeding subpopulation, thus facilitating the interchange of individuals between the Tensas (TRB) and Atchafalaya River Basins (UARB and LARB). The success of those translocations in the formation of the TRC subpopulation represents a significant improvement in Louisiana black bear demographic and genetic conditions since listing.

Abundance estimates for the TRC subpopulation are currently unknown. The mean annual estimated female survival rate (2002–2012) for the TRC subpopulation ranged from 0.93 (95% CI = 0.85–0.97) to 0.97 (95% CI = 0.91–0.99; Laufenberg and Clark 2014, p.31). Mean cub and yearling litter sizes for the same time period were 2.15 and 1.84 in the TRC subpopulation, respectively (Laufenberg and Clark 2014, p.35). Fecundity and yearling recruitment for the TRC subpopulation were 0.37 and 0.18 (Laufenberg and Clark 2014, p.31); low compared to the TRB subpopulation, but possibly an artifact of small sample size. The estimated asymptotic growth rates for the TRC ranged from 0.99 to 1.02 for Model 1 and Model 2, respectively (Laufenberg and Clark 2014, p.45). As male cubs born at TRC reach maturity and more males immigrate from the UARB subpopulation, growth rates of this subpopulation may increase (Laufenberg ad Clark 2014, pp. 70-80). TRC persistence probabilities ranged from 0.295 to 0.999 depending on estimated carrying capacity, the strength of the density dependence, level of uncertainty, and the treatment of unresolved signals (Laufenberg and Clark 2014, p.47). Probabilities of persistence were greater for all models where unknown fates were censored (Laufenberg and Clark 2014, p. 47). Using the telemetry and reproductive data from the TRC, probabilities of persistence were ≥0.95 only for projections based on the most optimistic set of assumptions (Laufenberg and Clark 2014, p.47).

Based on step-selection function modeling, the least potential for interchange by TRC bears was between the TRB, and the greatest proportion of successful projections was between the UARB (Laufenberg and Clark 2014, p. 74). As discussed previously, the TRC has experienced and possibly facilitated gene flow with other subpopulations (Laufenberg and Clark 2014, p. 84). Three males were captured in the TRB that had dispersed from the TRC, and 20 of 35 cubs sampled in the TRC showed evidence of having been sired by UARB males (Laufenberg and Clark 2014, p. 67). One TRC female dispersed to a location southwest of the TRB subpopulation and apparently bred with an Arkansas bear (Laufenberg and Clark 2014, p. 63) and recent LDWF capture records verify the presence of at least one WRB migrant in the TRC subpopulation (M. Davidson, LDWF, unpublished data). Laufenberg and Clark (2014, p. 83) detected direct evidence of interchange by bears from the UARB to the TRB subpopulation via the TRC subpopulation. They did not have any direct evidence of reverse movements; however, a male bear with UARB ancestry (possibly a second generation migrant) was captured at TRB indicating gene flow likely facilitated by the presence of the TRC subpopulation (Laufenberg and Clark 2014, p. 84).

<u>Louisiana Black Bears in Mississippi</u>

Black bear numbers are increasing in Mississippi (Simek et al. 2012, p.165). Shropshire indicated that the most reliable bear sightings reports occurred in 9 Mississippi counties (Bolivar, Coahoma, Issaquena, Warren, Adams, Wilkinson, Hancock, Stone and Jackson; Shropshire 1996, page 55, Table 4.1) and bear sightings were concentrated in 3 physiographic regions of Mississippi: Southern Mississippi Valley Alluvium [Delta], the Lower Coastal Plain, and the Coastal Flatwoods (Shropshire 1996, p. 57, Table 4.2;Young 2006, p.18)). The Mississippi population is currently estimated to be about 120 bears, with approximately 75 percent occurring within Louisiana black bear range (B. Young, MS Wildlife Federation, personal communication, 2013). Most of the sightings still occur along the Mississippi River and in the lower East Pearl River and lower Pascagoula River basins (Simek et al. 2012, p.164). Three new resident breeding populations have formed (first documented in 2005) in north west-central (Sharkey-Issaquena Counties), west-central (Warren County) and south west-central (Wilkinson County) Mississippi (Figure 1). Genetic studies and LDWF CMR studies have documented bear immigration from the WRB and TRB to the Sharkey-Issaquena and Warren county subpopulations and from TRC to the Wilkinson county subpopulation (Laufenberg and Clark 2014, p. 63-67).

Louisiana Black Bears in East Texas

At the time of listing, bears had not been reported in East Texas for many years, with the exception of the occasional wandering animal (Nowak 1986, p.7). Keul (2007, p. 1) reviewed historical literature on the black bear in East Texas and concluded that while habitat loss did occur, the primary reason for loss of bears was due to aggressive and uncontrolled sport hunting. The last known area supporting bears in East Texas was the Big Thicket area of Hardin County and forested areas in Matagorda County, which may have supported a few individuals up to the mid-1940s (Barker et al. 2005, p.6 ; Schmidley 1983. p.1). There was an episode of black bear sightings in East Texas during the 1960s following the reintroduction of Minnesota bears into Louisiana, but by 1983, Schmidley (1983, p.1) stated there were no resident bears remaining in East Texas.

Sightings of bears in East Texas have gradually increased since 1977, the time period when the Texas Parks and Wildlife Department (TPWD) started collecting data (Chappell 2011, p.11). Most of those sightings were believed to be juvenile or sub-adult males that had wandered into the northeastern part of the listed range from expanding populations in Oklahoma, Arkansas, and Louisiana (Barker et al. 2005, p.7). Observations in the 1990s indicated the return of a few black bears to the remote forests of East Texas, primarily transient, solitary males that were believed to be coming from Arkansas and Oklahoma (D. Holderman, TPWD, personal communication, 2013). Kaminski (2011, entire document) conducted a region-wide hair snare survey in east and southeast Texas in areas assumed to have the highest likelihood of bear occurrence and where sightings had been reported. According to genetic analyses and based on the estimated effectiveness of their sampling method, Kaminski (2011, pp. 34) determined it was highly unlikely there were established black bear populations in the region. Since 1990, there have been only 37 verified black bear sightings in 13 East Texas counties, and preliminary examination of these data suggest that some observations may represent duplicate sightings of individual bears (D. Holderman, TPWD, personal communication, 2013). There is currently no evidence of a resident breeding population of black bears in East Texas; however, bear recovery and range expansion in bordering Louisiana, Arkansas, and Oklahoma may increase bear occurrence and activity in East Texas in future years if sufficient habitat is available.

Louisiana Black Bear Population

Since listing there have been many studies of the Louisiana black bear's biology, taxonomy, denning ecology, nuisance behavior, movements, habitat needs, reintroduction efforts, and public attitudes (primarily in Louisiana, but also Mississippi and Texas). See Davidson et al. (2015, all pages) for a list of that research, and additionally, much of that work was summarized in the 5-year review (Service 2014). More recent studies have focused on population vital statistics for individual subpopulations, such as abundance, and associated vital rates (e.g., Hooker 2010; Lowe 2011, O'Connell 2013, Troxler 2013). Laufenberg and Clark (2014, entire document) incorporated the results of those studies and also conducted genetic structure and connectivity studies to examine the viability and connectivity of the greater Louisiana black bear population.

In summary, considering Laufenberg and Clark's (2014, entire document) and prior research, the following conditions exist for the Louisiana black bear population: (1) the size of the overall TRB and UARB subpopulations has increased since listing , their average population growth rates are stable to increasing, and the probability of long-term persistence for all subpopulations (except for one modeling scenario) was greater than 95 percent; (2) there is evidence of interchange of bears between the TRB, UARB , TRC, WRB, and Mississippi subpopulations; (3) there is evidence that TRB and UARB bears have emigrated to Mississippi and have contributed to the formation of resident breeding subpopulations that were not present at listing; (4) the areas supporting Louisiana black bear breeding subpopulations have increased and there is a more scattered distribution of breeding females between the original TRB and UARB subpopulation areas and the number and size of resident breeding populations and the habitat they occupy have increased (Figure 2, Table 2); and (5) a new breeding subpopulation, the TRC, that was not present at listing, now exists between the TRB and UARB subpopulations and facilitates interchange between those subpopulations.

The overall probability of persistence for the Louisiana black bear metapopulation (TRB,TRC, UARB) is estimated to be 0.996, assuming dynamics of the TRB, TRC, and UARB subpopulations were independent and using the most conservative population-specific persistence probabilities (i.e., 0.958, 0.295, and 0.849, respectively; Laufenberg and Clark 2014, p. 47). If subpopulations are not independent (i.e., some environmental processes affect all populations similarly), the long-term viability of the greater Louisiana black bear metapopulation could be reduced. However, the high persistence probabilities for the TRB and UARB subpopulations may negate that reduction because the probability that at least one subpopulation would persist would be as great as that for the subpopulation with the greater probability of persistence (which was greater than 95 percent; Laufenberg and Clark 2014, p. 80).

B. Habitat

In 1992, when the bear was listed, the lack of protection of forested habitat (particularly BLH) and the potential for any future losses of the already diminished and fragmented habitat was considered a threat to the Louisiana black bear population. To facilitate recovery, detailed "Louisiana Black Bear Habitat Restoration Planning Maps" were developed that delineated Habitat Restoration Planning Areas (HRPAs) where potential landowner enrollments in habitat restoration and conservation programs such as the Wetland Reserve program (WRP) may benefit Louisiana black bear populations (Figure 2). There has been a substantial increase in conservation lands (permanently protected lands that have been restored and/or protected) in the Louisiana Black Bear HRPA since listing; much of that has been targeted to support existing breeding subpopulations and/or to create movement corridors between those subpopulations (see Tables 2–7).

Upon delisting, there are approximately 137,000 ac (55,000 ha) of National Wildlife Refuges (NWRs) and 205,000 ac (83,000 ha) of state Wildlife Management Areas (WMAs) located within the Louisiana Black Bear HRPA, and 122,000 ac (49,000 ha) of NWRs and 20,000 ac (8,000 ha) of WMAs in the Mississippi Alluvial Valley Black Bear Priority Units (MAVU) of Mississippi (Figure 3). Forests of the Atchafalaya Basin (Basin) in Louisiana were not secure from development in 1992; however, since then, the Army Corps of Engineers has purchased over 47,000 ac (19,000 ha) of lands for public access and flood control and approximately 94,000 ac (38,000 ha) of the Basin are now protected through Corps environmental easements.

We use the term *breeding areas* or *breeding habitat* to identify areas that currently support reproducing subpopulations of the Louisiana black bear. In 2014, the Service and LDWF worked cooperatively to update the 2009 Louisiana black bear breeding habitat boundary within Louisiana. A similar effort was conducted to revise breeding habitat in Mississippi.

Those revisions were warranted based upon the substantial amount of new data that had been collected (from multiple sources including USGS and LDWF), and because those data suggested that the atypical female bear dispersal associated with the reintroduction project (conducted from 2001 to 2009) had primarily ceased. The foundation for the 2014 revisions methodology remained consistent with the previous versions (it was centered on known adult female locations and subpopulation-specific home range sizes). Telemetry data confirmation of any number of adult female bears was considered sufficient to include the associated habitat tract within the breeding habitat boundary. Individual bears and their specific movements were assessed to conclusively determine areas of permanent residence for adult female bears. In consideration for anthropogenic and natural landscape features, habitat contiguity, and forested habitat, certain forested habitat linkages were also included in our delineation based on their size, landscape position and demonstrated bear use. We also determined that naturally vegetated areas (i.e., non-agricultural habitats such as forest, scrub/shrub, marsh, etc.), contiguous to an area that is definitively determined to be breeding habitat, would also be considered breeding habitat. This determination was made because bear home ranges typically do not have rigid boundaries that are fixed throughout time.

Since 1992, over 148,000 ac (60,000 ha) of privately-owned forests have been restored and protected in the Louisiana Black Bear HRPA (Figure 3) through voluntary private landowner enrollment in the Natural Resource Conservation Service's (NRCS) Wetland Reserve Program (WRP). Approximately 97,000 ac (39,000 ha) directly benefit breeding populations and virtually all 148,000 ac (60,000 ha) may benefit movement between populations. All total, when permanent easement lands are added to the habitat protected on Federal NWRs and State WMAs, mitigation banks, and the numerous Corps fee title and easements, approximately 868,000 ac (440,000 ha) have been permanently protected and/or restored within the HRPAs in Louisiana (figure 3). Although not permanently protected, an additional 122,000 ac (49,400 ha) of lands currently enrolled in 15-year agreements via the Conservation Reserve Program (CRP) within the HRPAs provide habitat that may be used by bears. Approximately 42 percent of breeding habitat in the Louisiana Black Bear HRPA is under permanent protection (Tables 2–7).

Approximately 110,000 ac (41,000 ha) of private land in Mississippi counties adjacent to the Mississippi River have been enrolled in WRP 99-year and permanent easements within the MAVU. When WRP permanent easement lands are added to the habitat protected on Federal NWRs and State WMAs, other federal and state protected lands, and privately-owned protected lands, approximately 868,000 ac (440,000 ha) have been permanently protected and/or restored within the MAVU in Mississippi. Although not permanently protected, approximately 328,000 ac (132,737 ha) were enrolled in the CRP within the MAVU. Approximately 68 percent of breeding habitat in the MAVU is under permanent protection (Tables 2–7).

C. Residual Threats

Highway and other human-induced incidental mortalities as well as suspected illegal killing, threats since the time of listing, may continue to negatively affect Louisiana black bears. At least 246 black bears have been killed in vehicular collisions and at least 33 known poaching incidents have occurred during 1992–2014 (Davidson et al. 2015, p.15). Bear populations have grown in number and distribution in spite of these activities and, as a result, they may not represent a major threat to the Louisiana black bear or its habitat. The LDWF tracks those mortalities as part of their management plan (Davidson et al. 2015, pp. 15-16) using BearTrak (USGS et al. 2014) in order to identify and address areas of consistent mortality incidents. Enhancing or identifying potential habitat for conservation protection remains a primary goal of LDWF, and these actions will be employed using existing land conservation programs (Davidson et al. 2015, p. 30–36); which may reduce road mortalities by providing additional bear habitat. Additionally, potential locations for road crossing structures (e.g., wildlife highway underpass or overpass) are being investigated by LDWF along Interstate 20 and U.S. Highway 90 to mitigate road mortalities, and billboards and bear road crossing signs have been established along both of the aforementioned roadways (Davidson et al. 2015, p. 57). Public education by LDWF occurs routinely (e.g., hunter education, public informational meetings, teacher education workshops, outreach to urban and rural residents). Multiple educational materials are available from LDWF and their website to attempt to mitigate illegal bear kills (Davidson et al. 2015, p. 38–43). Finally, Louisiana black bears will remain protected under state laws and regulations, and the prosecution of illegal kills will continue to occur in adherence to those laws and regulations (Davidson et al. 2015, p. 53–55).

D. Management Commitments for Post-delisting Conservation

The LDWF will be the agency responsible for Louisiana black bear management upon delisting. A Louisiana Black Bear Management Plan (Plan) was developed in 2015 (Davidson et al. 2015). The management objective for that Plan is to maintain a sustainable black bear population in suitable habitat and has the following key requirements of sufficient habitat available within dispersal distance, maintaining or creating connectivity among subpopulations, and continued monitoring of subpopulation demographics and genetics (Davidson et al. 2015, p. 2). The LDWF identified three bear management actions they will implement: (1) continued public education and outreach; (2) minimizing human bear conflicts; and (3) bear harvest as a management action if such actions do not impede sustainability of bears (Davidson et al. 2015, p. 41). Demographic research on Louisiana black bear subpopulations has been conducted since its listing. In 2006, the LDWF and partners engaged the USGS to implement an intensive, science-based research program to assess the demographic characteristics of the four subpopulations and evaluate the overall population viability (Laufenberg and Clark 2014, entire document). The data developed over the last 6 or more years incorporate traditional bear monitoring techniques, such as vital rates obtained from trapping, but have also created the capability to accurately assess exchange between subpopulations and the viability of the greater black bear population as a whole. The LDWF will continue to monitor Louisiana black bear demographic and genetic characteristics for individual subpopulations as well as range expansion (Davidson et al. 2015, Table 3.1). The population monitoring for this PDM plan is based on those research data and has been included as part of the LDWF Management Plan.

The LDWF is responsible for administering the many State-owned WMAs in Louisiana. The WMAs within the HRPA include Big Lake WMA (19,587 ac (7,927 ha)), Buckhorn WMA (11,238 ac (4,548 ha)), Richard K. Yancy WMA (73, 433 ac (29,717 ha)), Spring Bayou WMA (),Grassy Lake WMA (13,214 ac (5,348 ha)), Sherburne WMA and the adjacent (State-managed) Corps–owned Bayou Des Ourses Area (29,883 ac (12,093 ha)), and Attakapas Island WMA (26,819 ac (10,854 ha)). Those areas are managed according to the LDWF Master Plan for Wildlife Areas and Refuges (LDWF 2014). The goals for that plan are to: (1) Sustain a range of facilities and uses for the public to enjoy LDWF lands; (2) Provide a green infrastructure vision for LDWF to implement and manage landscape scale conservation; (3) Provide the public, LDWF personnel, and key stakeholders with useful reference documents on important information and policies; and (4) Identify focused restoration efforts to maximize impact for ecosystems and leveraging partner resources (LDWF 2014, pp. 15–16).

U.S. Fish and Wildlife National Wildlife Refuges

The numerous large tracts of federal public land on which black bear subpopulations occur are all managed according to long-term management plans. The following NWRs occur within the HRPA: TRNWR (77,956 ac (31,548 ha)), Bayou Cocodrie NWR (15,150 ac (6,131 ha)), Lake Ophelia NWR (17,427 ac (7,053 ha)), Atchafalaya NWR (15,764 ac (6,379 ha)), and Bayou Teche NWR (9,005 ac (3,664 ha)). The National Wildlife Refuge System Improvement Act of 1997 requires that every refuge develop a Comprehensive Conservation Plan (CCP) and revise it every 15 years, as needed. CCPs identify management actions necessary to fulfill the purpose for which a NWR was enacted. CCPs allow refuge managers to take actions that support State

Wildlife Action Plans, improve the condition of habitats and benefit wildlife. The current generation of CCPs will focus on individual refuge actions that contribute to larger, landscape-level goals identified through the Landscape Conservation Design process. Comprehensive conservation plans address conservation of fish, wildlife, and plant resources and their related habitats, while providing opportunities for compatible wildlife-dependent recreation uses. An overriding consideration reflected in these plans is that fish and wildlife conservation has first priority in refuge management, and that public use be allowed and encouraged as long as it is compatible with, or does not detract from, the Refuge System mission and refuge purpose(s). Each NWR within LBB range addresses management actions for maintaining appropriate bear habitat on their lands (Service 2009a, pp. 77-78 (Tensas); Service 2009b, p.34 (Teche); Service 2011, p.68-75 (Atchafalaya); Service 2006, p.54 (Grand Cote); Service 2008, pp.85-86 (Ouachita); Service 2005, pp.49-50 (Lake Ophelia); Service 2004, p.40 (Bayou Cocodrie)

<u>Morganza and Atchafalaya Basins</u>

The lands in the Atchafalaya Basin and Morganza Floodway are prominent features of the Mississippi River and Tributaries flood control project authorized by the Flood Control Act of May 15, 1928. In 1985, the U.S. Army Corps of Engineers (Corps) enacted the Atchafalaya Basin Multipurpose Plan with the purpose to protect south Louisiana from Mississippi River floods and to retain and restore the unique environmental features and long-term productivity of the Basin (USCOE 1983). The purpose of the Morganza Floodway is to provide a controlled floodway to divert Mississippi River flood waters into the Atchafalaya basin during major floods on the Mississippi River. The Corps has acquired fee title ownership and permanent easements of approximately 600,000 ac (200,000 ha) for perpetual flowage, developmental control and environmental protection rights. The developmental control and environmental protection easement prohibits conversion of land from existing uses (e.g., conversion of forested lands to cropland). Landowners may harvest timber only in compliance with specified diameter-limit and species restrictions. The construction or placement of new, permanently habitable dwellings or other new structures, including camps, except as approved by a Corps real estate camp consent and in accordance with Corps restrictions, is prohibited on the easement lands in the Atchafalaya Basin.

<u>NRCS Administered Permanent Conservation Easement on Private Lands</u>

The WRP is a voluntary program that provides eligible landowners the opportunity to address wetland, wildlife habitat, soil, water, and related natural resource concerns on private lands in an environmentally beneficial and cost-effective manner. The WRP is authorized by 16 U.S.C. 3837 et seq., and the implementing regulations are found at 7 CFR 1467. The first and foremost emphasis of the WRP is to protect, restore, and enhance the functions and values of wetland ecosystems to attain habitat for migratory birds and wetland-dependent wildlife, including threatened and endangered species. The WRP is administered by the NRCS (in agreement with the Farm Service Agency) and in consultation with the Service and other cooperating agencies and organizations. The Service participates in several ways, including assisting NRCS with land eligibility determinations; providing the biological information for determining environmental benefits; assisting in restoration planning such that easement lands achieve maximum wildlife benefits and wetland values and functions; and providing recommendations regarding the timing, duration, and intensity of landowner-requested compatible uses.

Land that is eligible for enrollment in the WRP includes such areas as wetlands cleared or drained for farming, pasture, or timber production; certain adjacent lands that contribute significantly to wetland functions and values; restored wetlands that need long-term protection; and existing or restorable riparian habitat corridors that connect protected wetlands. Eligible land must be restorable and suitable for providing wildlife benefits. Thus, the WRP provides an incentive for private landowners to restore non-productive farmland (prior-converted wetlands), and in Louisiana the majority of WRP land under permanent easement is agricultural land that is being restored to its original bottomland hardwood forest habitat.

Under the WRP, there are three enrollment options available for the landowner: (1) Permanent/perpetual easement; (2) 30-year easement; and (3) restoration cost-share agreement. Under the permanent easement option, a conservation easement is placed upon the enrolled lands for perpetuity. When a landowner enrolls in an easement option, the landowner is selling a real property interest to the United States. After the easement is recorded in the local lands record office, the landowner retains ownership and responsibility for the land. The landowner controls access to the land; has the right to hunt, fish, and pursue other undeveloped recreational uses provided such use does not impact other prohibitions listed in the warranty easement deed; and may sell or lease land enrolled in the program.

Participating landowners may request other prohibited uses such as haying, grazing, or harvesting timber. When evaluating compatible uses, the NRCS evaluates whether that proposed use is consistent with the long-term protection and enhancement of the wetland resources for which the easement was established and Federal funds expended. Requests may be approved if the NRCS determines that the activity both enhances and protects the purposes for which the easement was acquired and would not adversely affect habitat for migratory birds and threatened and endangered species. NRCS retains the right to cancel an approved compatible use authorization at any time if it is deemed necessary to protect the functions and values of the easement. According to the authorizing language (16 U.S.C. 3837a(d)), compatible economic uses, including forest management, are permitted if consistent with the long-term protection and enhancement of the wetland resources for which the easement was established. Should such a modification be considered, NRCS would consult with the Service prior to making any changes.

Lands that have been permanently protected through WRE (formerly WRP easements) are According to the WRP Manual, found in Title II (Conservation) of The Farm Security and Rural Investment Act of 2002 (2002 Farm Bill; Public Law 107-171), prior to making a decision regarding easement termination, the Natural Resources Conservation Service (NRCS) must: (1) Consult with the Service; (2) investigate whether reasonable alternatives to the proposed action exist; and (3) determine whether the easement modification is appropriate considering the purposes of WRP and the facts surrounding the request for easement modification or termination. Any WRP easement modification, including termination, must: (1) Be approved by the Director of the NRCS in consultation with the Service (the National WRP Program Manager must coordinate the consultation with the Service at the national level); (2) not adversely affect the wetland functions and values for which the easement was acquired; (3) result in equal or greater ecological (and economic) values to the U.S. Government; (4) further the purposes of the program and address a compelling public need; and (5) comply with applicable Federal requirements, including the Act, the National Environmental Policy Act (42 U.S.C. 4321 et seq.), Executive Order 11990 (Protection of Wetlands), and related requirements. At least 90 days before taking any action to terminate an easement, the Secretary of the Department of Agriculture must provide written notice of such action to the Committee on Agriculture of the U.S. House of Representatives and the Committee on Agriculture, Nutrition, and Forestry of the U.S. Senate. Therefore, based on our assessment of these requirements, the termination of a WRP easement appears highly improbable. In addition, our Lafayette Ecological Services Field Office has partnered with NRCS to administer WRP in Louisiana since the inception of that program in 1992. Following a comprehensive review of our local files, and a search of national WRP records, we have been unable to find a single instance of a WRP easement being terminated in the history of that program (which includes nearly 10,000 projects on approximately 2 million ac (800,000 ha) of land nationwide).

V. Monitoring Focus

The overarching objective of the Louisiana Black Bear Recovery Plan is *"…to sufficiently alleviate he threats to the Louisiana black bear metapopulation, and the habitat that supports it, so that the protection afforded by the Endangered Species Act is no longer warranted"* (Service 1995, p. 14). The LBB was listed as a threatened species primarily because of historical modification and reduction of habitat, the reduced quality of remaining habitat due to fragmentation, and the threat of future habitat conversion and human-related mortality (57 FR 588). An indirect result of that fragmentation was isolation of the already small subpopulations, subjecting them to threats from such factors as demographic stochasticity, genetic drift, and inbreeding. The recovery plan contains numeric goals for viable subpopulations as having a 95 percent or better chance of persistence over 100 years. Long-term protection is defined as having sufficient voluntary conservation agreements with private landowners and public land managers so that habitat degradation is unlikely to occur over 100 years. The Recovery Plan includes the following criteria to consider the LBB for delisting: (1) at least two viable subpopulations, one each in the Tensas and Atchafalaya River Basins [Louisiana]; (2) immigration and emigration corridors between the two viable subpopulations; and (3) long-term protection of the habitat and interconnecting corridors that support each of the two viable subpopulations used as justification for delisting.

Therefore, the focus of post-delisting monitoring for the Louisiana black bear will occur in Louisiana and consist of two components: (1) population demographics and vital statistics monitoring consisting of regular live-capture (including collection of genetic material), radio-collaring, winter den checks, and radio-telemetry monitoring to estimate recruitment (f), survival (S), genetic exchange, and cause-specific mortality in a timely manner; and non-invasive mark-recapture methods to estimate change in population size (λ), apparent survival (φ), per-capita recruitment (f), and genetic exchange for future viability analyses, if needed, and (2) a habitat-based component consisting of periodic assessments of habitat abundance, persistence, and any changes in protection using interpretation of remotely sensed data and updated GIS information (e.g., conservation easements) range-wide within the HRPA and in specific geographic areas supporting and surrounding the TRB, TRC, UARB, and LARB subpopulations of the Louisiana black bear. The methods described below were developed based on the best known methods currently available. Should newer methods for population monitoring or habitat trend assessment become available during the post-deleting monitoring period that may improve our ability to better evaluate trends, those methods would be explored.

Multiple monitoring strategies will be used for the individual subpopulations in order to assure that demographics and habitat status will be captured at differing time periods and scale, respectively as described below19-24.). Because the TRB and UARB subpopulations were identified as necessary for recovery and delisting (Service 1995, p.14) of the subspecies, intensive monitoring will occur annually for 7 years within each of these subpopulations following the delisting of the subspecies to monitor Louisiana black bear population vital rates. Although monitoring of the TRC and LARB subpopulations will occur during the 7-year period, it will be less intensive than that of the monitoring for TRB and UARB (Table 1).

A. Population Demographics

There is an approximate 1-year time lag in obtaining demographic estimates from non-invasive DNA sampling due to the time required for processing and genotyping DNA hair samples (see below). Therefore, to provide near real-time evaluation of subpopulation health, trends in reproduction (reproductive status, litter size, and cub and yearling survival) and vital statistics (adult survival and cause-specific mortality) will be monitored in the TRB, UARB, TRC, and LARB subpopulations by the annual live-capture of bears, winter female den visits, and monthly monitoring of radio-collared bears.

Demographic data for the TRB and UARB populations will be estimated using similar methods used for recovery monitoring in the TRB and UARB (2006–2012; Laufenberg and Clark 2014). This will allow for post-delisting data to be evaluated against the previous 5 to 6 years of recovery data and facilitate the ability to better evaluate any observed post-delisting demographic changes within the framework of acceptable annual variations. These data will be collected by the LDWF using non-invasive DNA sampling (via hair snares), live-trapping, telemetry-based monitoring, winter den checks, and CMR analyses (Table 1; Laufenberg and Clark 2014 p. 16–17).

The TRC is a relatively new subpopulation that resulted from a reintroduction project ([2001–2009]; Benson and Chamberlain 2007,pp. 2393-2403; Davidson et al. 2015, p.27) and did not exist at the time listing of the subspecies occurred. As is often the case with reintroduced populations, a time delay typically occurs between reintroduction and saturation of the release area (Seddon 1999); primarily due to the inherent biological characteristics of bears (e.g., low reproductive rates and long generation intervals [Bunnell and Tait 1981, p. 75–98]). Because the reintroduction project at TRC ended relatively recently (2009), it is unlikely that the subpopulation has saturated the entire release area yet (S. Murphy, LDWF, personal communication). The LDWF has established a long-term monitoring protocol for the TRC, which includes non-invasive DNA sampling in a CMR approach at 5-year intervals beginning in 2014 to estimate abundance (N) and λ using CMR models (Otis et al. 1978, p.9–11) and an exponential growth equation (Gotelli 2008), respectively. Additionally, live-trapping to deploy radio-collars and winter den checks at TRC were used by Laufenberg and Clark (2014) to monitor *S* and *f*, and will continue to be conducted annually by LDWF during the 7-year post-delisting monitoring period (Table 1).

Habitat characteristics in the area occupied by the LARB subpopulation, including marsh and other year-round inundated ecosystems, cause substantial difficulty in using non-invasive DNA sampling to monitor subpopulation trends. Therefore, monitoring of the LARB by LDWF will occur using live-trapping, radio-collaring, and winter den checks (Table 1). Although these methods require substantial effort, they allow the estimation of *S* and *f*, which can be used to derive estimates of λ (Schwartz and Arnason 1996).

Should annual acquired demographic data indicate some concern for the populations (see TRIGGERS Section below), population viability models may be reanalyzed.

J. Clark (USGS, unpublished report) used existing CMR recovery data for the TRB and UARB populations (2006–2012) to determine the sensitivity and accuracy of various estimators to detect population changes. Based on those analyses, Pradel robust design models (Pradel 1996) will be used to estimate the rate of change in population size for post-delisting monitoring of the TRB and UARB populations. Rate-of-change (λ) will be monitored because estimates of *N* are sensitive to sampling biases, whereas estimating λ is more robust to potential bias that might be caused by unequal catchability, and these models allow the estimation of λ in the absence of *N* estimates (Pradel 1996, J. Clark, USGS, unpublished report). Additionally, the use of a Pradel estimator is a more sensitive measure of population demographics and allows for the evaluation of other demographic components of any observed change, such as apparent survival (φ) and per-capita recruitment (f); as well as incorporation of environmental variables, such as weather and flooding (Pradel 1996). A sensitivity analysis of Louisiana black bear demographic parameters is currently being conducted to better inform the decision threshold for post-delisting monitoring. Those methods, which can only improve monitoring accuracy, will be incorporated where appropriate once they are developed (J. Clark, USGS, personal communication).

B. Habitat Persistence

Monitoring the habitat status over such a large geographic range will require the use of several direct and indirect measures. Spatial and temporal locations of habitat protection and the status of that habitat in the HRPA will be monitored during the 7-year post delisting monitoring period. We will use available updates of many of the same data sources as used during recovery. Monitoring at small resolution will be used to directly track changes in forested habitat using National Agriculture Imagery Program (NAIP), Natural Resources Conservation Agency (NRCS) hydrologic soils data and permanently protected areas (NRCS conservation easements, public wildlife areas [NWRs and WMAs]) (Table 1). Additional remotely sensed data (e.g., National Land Cover Dataset [NLCD] developed by the Multi-Resolution Land Characteristics [MRLC] Consortium, USDA CropScape data) will also be monitored for potential habitat conversion trends at a larger scale within the HRPA.

VI. Sampling Designs and Methodologies

A. Population Monitoring

The post-delisting monitoring methods for evaluating λ at TRB and UARB are those developed by J. Clark (USGS, unpublished report; Attachment 1) based upon experience in previous studies of Louisiana black bear ecology (2006-2012). Population data will be acquired by LDWF through population mark-recapture efforts using collection of hair samples. All methods are the same as those used for the 2006–2012 research (Laufenberg and Clark 2014, pp. 7-20), except sampling will occur annually for 3 weeks instead of 8 weeks over a 7-year period (J. Clark, USGS, unpublished report). Additionally, mark-recapture efforts to collect hair samples will be conducted at TRC and on lands between TRC and TRB at 5-year intervals beginning in 2014 to estimate N and λ, and to investigate gene flow between the TRC and other subpopulations. Finally, LDWF will monitor reproductive rates annually in the TRB, UARB, TRC, and LARB subpopulations by conducting winter natal den checks, and survival and cause-specific mortality in these subpopulations will be continuously monitored by the live-trapping and radio-collaring of bears.

TRB and UARB:

To monitor potential changes in the demographic (φ, λ, and f) and genetic parameters in the TRB and UARB subpopulations, non-invasive hair traps will be placed in pre-defined systematic grids to collect black bear hair for microsatellite DNA analysis. Simulations indicated the utilization of non-invasive hair traps in a robust design CMR framework for 3 consecutive sampling sessions during each of 7 consecutive years (i.e., 3 secondary sessions during 7 consecutive primary sessions) would yield enough power to detect a 5% change in λ for the 2 subpopulations combined (J. Clark, USGS, unpublished data). Therefore, LDWF has established 2 separate sampling grids, one each in the TRB and UARB subpopulations, respectively. Sampling grids utilizing a spacing of 1.9 km^2 x 1.9 km^2 were constructed and superimposed across the landscape using ArcMap 10.1 (ESRI, Redlands, California, USA). Final sampling grids are composed of 209 and 116 sampling cells at TRB and UARB, respectively. Hair trap spacing was determined by the average annual female home range size of Louisiana black bears based on existing radio-collar data (Murrow and Clark 2012, p. 196). The spacing utilized ensures 4 hair traps were established within the average annual female home range size of Louisiana black bears as recommended by Settlage et al. (2008, p. 1040). A single baited, barbed-wire hair trap is constructed within each sampling cell to collect black bear hair. LDWF constructed all hair traps using 2 wires placed 35 cm and 65 cm above the ground; each were wrapped around 3–5 perimeter trees to form an enclosed polygon. Hair traps are baited with pastries and raspberry scent and traps are checked weekly for 3 consecutive weeks during June of each year over a 7-year timeframe. Traps are not moved between or during any sampling sessions. Each barb on the barbed-wire is treated as an individual sample, and hairs are removed using tweezers that were sterilized between collections. Only samples containing $\geq$ 5 hairs are collected. The collected hair samples are placed in individually labeled paper coin envelopes that are stored at room temperature. A flame is used to sterilize barbs following individual sample collections in an attempt to prevent cross-contamination of samples. Collected hair samples are sent to Wildlife Genetics International (WGI; Nelson, British Columbia, Canada) for DNA extraction and amplification, and genotyped using microsatellite markers (described below).

TRC:

To estimate N, λ, density (D), and genetic characteristics of bears in the TRC subpopulation at 5-year intervals, beginning in 2014, non-invasive hair traps are placed in a pre-defined systematic grid encompassing the entirety of the reintroduction area (Benson and Chamberlain, 2007, p. 2394). A sampling grid utilizing a spacing of 2.5 km^2 x 2.5 km^2 was constructed and superimposed across the landscape using ArcMap 10.1 (ESRI, Redlands, California, USA), and a final sampling grid composed of 140 contiguous sampling cells that covered a 875-km^2 area was used (Figure 4). Hair trap spacing was determined by the average annual female home range size of Louisiana black bears based on existing radio-collar data (Murrow and Clark 2012, p. 196). The spacing utilized ensures at least 2 hair traps were established within the average annual female home range size of Louisiana black bears. A larger spacing was used for TRC than for TRB and UARB because the extent of occupied bear range at TRC was unknown; therefore 2 hair traps per female home range allowed sampling of a larger area. A single baited, barbed-wire hair trap is constructed within each sampling cell to collect black bear hair. All hair traps are constructed using 2 wires placed 35 cm and 65 cm above the ground; each are wrapped around 3–5 perimeter trees to form an enclosed polygon. Traps are baited with pastries and raspberry scent and traps are checked weekly for 8 consecutive weeks from June to August at 5-year intervals beginning in 2014. Traps are not moved between or during any sampling sessions. Each barb on the barbed-wire is treated as an individual sample, and hairs are removed using tweezers that are sterilized between collections. Only samples containing $\geq$ 5 hairs are collected. The collected samples are placed in individually labeled paper coin envelopes that are stored at room temperature. A flame is used to sterilize barbs following individual sample collections in an attempt to prevent cross-contamination of samples. Collected hair samples are sent to Wildlife Genetics International (WGI; Nelson, British Columbia, Canada) for DNA extraction and amplification, and genotyped using microsatellite markers (described below).

Connectivity Between Subpopulations:

To investigate subpopulation connectivity and gene flow (Dixon et al. 2006, p. 157) between the TRC and TRB subpopulations, LDWF has established a linear non-invasive hair trap transect between the TRB and TRC subpopulations to collect black bear hair at 5-year intervals, beginning in 2014. A sampling grid utilizing a spacing of 2.5 km^2 x 2.5 km^2 was constructed and superimposed across the landscape using ArcMap 10.1 (ESRI, Redlands, California, USA), and a final sampling grid composed of 94 contiguous sampling cells that covered a 587.5-km^2 area was used (Figure 4). Hair trap spacing was determined by the average annual female home range size of Louisiana black bears based on existing radio-collar data (Murrow and Clark 2012, p. 196). The spacing utilized ensures at least 2 hair traps were established within the average annual female home range size of Louisiana black bears. A larger spacing was used for this transect than for TRB and UARB because the extent of occupied bear range in this corridor was unknown; therefore 2 hair traps per female home range allowed sampling of a larger area. A single baited, barbed-wire hair trap is constructed within each sampling cell to collect black bear hair. All hair traps are constructed using 2 wires placed 35 cm and 65 cm above the ground; each are wrapped around 3–5 perimeter trees to form an enclosed polygon. Traps are baited with pastries and raspberry scent and checked weekly for 8 consecutive weeks from June to August at 5-year intervals beginning in 2014. Traps are not moved between or during any sampling sessions. Each barb on the barbed-wire is treated as an individual sample, and hairs are removed using tweezers that are sterilized between collections. Only samples containing ≥ 5 hairs are collected. Collected samples are placed in individually labeled paper coin envelopes that are stored at room temperature. A flame is used to sterilize barbs following individual sample collections in an attempt to prevent cross-contamination of samples. Collected hair samples are sent to Wildlife Genetics International (WGI; Nelson, British Columbia, Canada) for DNA extraction and amplification, and genotyped using microsatellite markers (described below).

Additionally, connectivity and genetic interchange between TRB and UARB will also be monitored annually using genetic data from the non-invasive hair sampling protocol described in the "TRB and UARB" subsection above.

Reproduction and Survival

To monitor temporal trends in reproductive vital rates and survival in the TRB, TRC, UARB, and LARB subpopulations, Louisiana black bears will be live-captured and radio-collared annually. Bears will be captured using Aldrich spring-activated foot snares (Aldrich Animal Trap Company, Clallam Bay, Washington), culvert traps, and free-range darting. Captured bears will be immobilized using Telazol® (Fort Dodge Animal Health, Fort Dodge, Iowa, USA) at a dosage of 4−5 mg per kg of estimated body mass. After latency, bears will be placed in lateral or sternal recumbency, sterile ophthalmic lubricant applied to prevent corneal desiccation, and blindfolds secured to reduce visual stimulation and sunlight caused retinal damage. Body temperature, respiration, and pulse will be monitored throughout each immobilization. Captured bears will be fitted with mortality-sensitive radio-collars (Telonics, Mesa, Arizona, USA). All collars will have a leather spacer to serve as a release mechanism. All individuals will receive unique lip tattoos, plastic ear tags, and passive integrated transponder (PIT) tags. Existing marks, morphometric measurements, estimated age class, general condition, and reproductive status will be recorded for all bears. First premolars will be extracted for age determination by cementum annuli analysis. Monitoring of collared bears will take place with monthly aerial telemetry flights during the non-denning months (April–December) to determine survival of radio-collared individuals. Radio-collared females will be located by VHF signal during January–March to enable the execution of den checks for determining reproductive status and litter size. When females are immobilized in natal dens, the cubs will be weighed, sexed, have PIT tags inserted subcutaneously, and hair samples will be collected for DNA analyses. Radio-collared females will be opportunistically located by ground telemetry during May–October to conduct post-den emergence observations of family groups to verify reproductions.

B. Habitat Monitoring

Historic loss and fragmentation of habitat (primarily as a result of conversion to agriculture), future threat of conversion, and the resulting impacts on Louisiana black bear populations were the primary reason for the listing of this species. The continued existence of habitat supporting the two recovery populations and the habitat that interconnects them are key to

Louisiana black bear recovery. Habitat protection of those areas has been achieved through permanent protection via acquisition by federal and state wildlife refuges and management areas, permanent WRP easements, and the regulatory protection of wetland habitat achieved through Section 404 of the Clean Water Act of 1977 (an amendment to the Federal Water Pollution Control Act of 1972) and the Wetland Conservation (i.e., Swampbuster) provisions of the Farm Security and Rural Investment Act of 2002. Changes (positive and negative) in Louisiana black bear forested habitat within the HRPA will be monitored at several spatial scales by the FWS with the large scale providing site-specific habitat changes resulting from private landowner actions or the Section 404 permitting program among the subpopulations that comprise the viable Louisiana black bear metapopulation (e.g., TRB, TRC, and UARB). Small scale data will be collected over the entire HRPA geographic area to provide information on overall trends with the HRPA and the LMAV relative to all the Louisiana black bear subpopulations. Habitat will be monitored following delisting using the following approaches.

<u>LBB Forested Habitat within Jurisdictional Wetlands</u>

High-resolution NAIP aerial photography (1 meter resolution) will be utilized to track changes in Louisiana black bear habitat between the TRB, TRC and UARB subpopulations over time. Evaluation at this scale will allow tracking of smaller habitat changes resulting from such things as CWA permitting and private actions. The imagery will be classified into suitable/non-suitable black bear habitat using the Geographic Information System (GIS) software (ArcGIS Feature Analyst®). Several commercially available software packages were evaluated, Feature Analyst provided the most straightforward for non-supervised classification and repeatability over time. The habitat classes will be coalesced with NRCS hydric soils coverage data (SSURGO) to identify jurisdictional wetlands within existing Louisiana Black Bear Habitat Restoration Planning Areas (HRPA). A subset of those jurisdictional wetlands will be monitored over the post-delisting time period (7 years) by overlaying the analysis-area polygons onto NAIP imagery and the LDWF bear sampling grids (Figure 4) and determining (via digitizing/GIS change detection analysis) changes to forested/shrub-scrub habitat for the 2013, 2016, and possibly 2019 (if the data are available) assessment periods. No unsupervised classification program will ever be 100 percent accurate because often times two different land-type features may produce the same spectral signature. Preliminary change analyses indicated that small areas (e.g., less than approximately 1.5%) such as tree shadowing along a bayou or property line, may produce the same reflectance as low suspended sediment waterbodies. Therefore, resulting classifications will be reviewed by a GIS analyst to correct any obvious misclassifications. Corrections will be made to ensure conservative estimates of forest classes will produced (i.e., if a particular area's classification cannot be resolved with certainty, it will not be classified as forested habitat).

The NAIP aerial imagery is acquired during the agricultural growing season with a goal of making the digital ortho-photography available to governmental agencies and the public within one year of acquisition. Starting in 2009 the imagery is acquired on a 3-year cycle (prior to that the cycle was every 5 years). NAIP imagery is acquired at a one-meter ground sample distance (GSD) with a horizontal accuracy that matches within six meters of photo-identifiable ground control points, which are used during image inspection. The default spectral emulsion is natural color (Red, Green and Blue, or RGB) but beginning in 2007, some states have been delivered with four bands of data: RGB and Near Infrared (USDA website 2013, http://www.apfo.usda.gov/FSA/apfoapp?area=home&subject=prog&topic=nai). The NRCS soils data (SSURGO) contains information about soil as collected by the National Cooperative Soil Survey over the course of a century. The information can be displayed in tables or as maps and is available for most areas in the United States and the Territories, Commonwealths, and Island Nations served by the USDA-NRCS. The information was gathered by walking over the land and observing the soil. Many soil samples were analyzed in laboratories. The maps outline areas called map units. The map units describe soils and other components that have unique properties, interpretations, and productivity. The information was collected at scales ranging from 1:12,000 to 1:63,360. More details were gathered at a scale of 1:12,000 than at a scale of 1:63,360. These datasets have been aggregated by USDA-NRCS into hydric and non-hydric soil classes (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/?cid=nrcs142p2_053627).

National Land Cover Database (NLCD) Change Detection

NLCD data is available approximately every 5 years and has a 30 m resolution. These data will be monitored when available for small-scale estimates of habitat within the HRPA. NLCD digital grid (raster) data is developed by The Multi-Resolution Land Characteristics Consortium (MRLC). The MRLC is a group of Federal agencies who develop datasets used to track regional and global changes in land cover and land use, including such essential categories as forest and grassland cover. The MRLC consortium is specifically designed to meet the current needs of Federal agencies for nationally consistent satellite remote sensing and land cover data. We will transform the digital raster data to a vector format in order to obtain the most accurate estimates of habitat delineations and change over time. We will use the most recent (2011) data to provide a baseline from which habitat trends can be assessed as future NLCD data sets (presumably 2016 and 2021) become available. NLCD is available 2-3 years after imagery is collected. NLCD 2011 was available for download in March 2014. The last satellite imagery panel was collected in November 2011.

Monitoring Change in Agricultural Land Uses using CropScape

The NRCS Cropland Data Layer (CDL) product provides categorized land-cover information encompassing the whole contiguous United States. Using the latest Web and geospatial interoperability technologies, CropScape was built to visualize, query, disseminate, and analyze historical and current CDL data interactively and intuitively over the Internet. The CDL is a raster, geo-referenced, crop-specific land cover data layer created annually for the continental United States using moderate resolution satellite imagery and extensive agricultural ground truth (Han et al. 2014, pp.129-138). We will use the CDL data to track annual changes in conversion of forested habitat into croplands (and vice versa) within the buffered habitat boundaries on a landscape scale. This tracking may serve to provide early alerts to potential trends towards cropland development and indirectly potential effects to LBB habitat.

Monitoring Changes in Permanently Protected Lands

We will obtain annual updates (and metadata) for state and federally owned lands, and the USDA-NRCS digital WRP permanent easement enrollments within the Louisiana black bear habitat restoration planning area changes to those tracts. We will summarize acreage totals for those tracts and also depict there locations spatially using Geographic Information System (GIS) software (ArcGIS (ESRI, Redlands, California, USA) within the monitoring area after each annual update.

C. Sampling and Data Analyses

Laboratory Analyses of Hair Samples

All DNA extraction and amplification of hair samples will be conducted by Wildlife Genetics International (WGI; Nelson, British Columbia, Canada). For the monitoring of the TRB and UARB subpopulations, a total of 113 hair samples per week (339 samples per year) will be randomly selected from the pool of TRB and UARB samples for microsatellite analysis to achieve the desired probability for detecting a 5% change in λ, based on simulations (J. Clark, U. S. Geological Survey, unpublished data). To estimate N, λ, and genetic characteristics of the TRC subpopulation at 5-year intervals, 2 samples per hair trap per sampling session will be used as a subsampling protocol so as to maximize the number of unique individuals identified while also providing robust demographic estimates (Laufenberg 2010). Personnel at WGI will randomize samples from each site-week and select the first sample encountered containing 5 guard hair roots or $\geq$ 20 underfur hairs. If no samples at a site-week meet this threshold, the best available sample will be chosen using a threshold of 1 guard hair root or 5 underfur hairs (D. Paetkau, WGI, personal communication to S. Murphy, LDWF). Following standard protocols (Woods et al. 1999, Paetkau 2003), DNA will be extracted using QIAGEN DNeasy Blood and Tissue spin columns. A minimum of 8 and up to 23 black bear-specific microsatellite loci will be used to identify individual black bear according to the methods described by Paetkau and Strobek (1994). A gender marker will be used to delineate sex of identified individuals (Ennis and Gallagher 1994). To minimize genotyping error and mitigate incorrect identification of individuals, WGI will discard samples that fail at >3 markers on the first pass of amplification. Additionally, samples with 1–3 misidentified pairs will be reanalyzed, and samples without complete genotypes for all markers will be discarded. Finally, error-checking will be completed by reanalyzing pairs of samples with genotypes matching at all-but-one (1-MM pairs) or all-but-two markers (2-MM pairs) to determine if differences exist at each locus (D. Paetkau, WGI, personal communication). This process effectively ensures that the number of individuals identified has not been inflated through undetected genotyping error (Paetkau 2003, p.1384–1385).

Population Genetics

Genetics data will initially be used to identify individuals for CMR analyses to estimate demographic parameters. Additional information can be gathered from microsatellite data, though; which can give insight into the genetic health of populations. The LDWF will use these genetics data to monitor the genetic health of Louisiana black bears by estimating genetic diversity, effective population size, and the number of migrants, as well as investigating population structure and gene flow between subpopulations. Microsatellite marker data will be tested for Hardy-Weinberg equilibrium (HWE) between genotypes with Program Genepop 4.2 using the complete enumeration method and a Markov Chain sampling regime (Guo and Thompson 1992, p. 364–367; Raymond and Rousset 1995, p. 248). Linkage disequilibrium, the failure of alleles at 2 loci to be statistically independent, will be investigated using the linkage disequilibrium test in Genepop 4.2 (Raymond and Rousset 1995, p. 248) with P-values adjusted using a Bonferroni sequential correction. Genetic diversity as expected heterozygosity (H_E) will be estimated using the allele identity method in Genepop 4.2 (Raymond and Rousset 1995, p. 248). To estimate effective population size (N_E), the linkage disequilibrium test (Hall 1981) in NeEstimator v2 (Do et al. 2014) will be used. Finally, to investigate population structure and immigration, the genetics data will be combined with that of Laufenberg (2014) and analyzed in program STRUCTURE (Pritchard et al. 2000) using the same methods described in Laufenberg (2014, p. 40–43), and the migration rate (i.e., level of gene flow) between subpopulations will be estimated as the number of migrants per generation (N_m) using the private allele method in Program Genepop 4.2 (Raymond and Rousset 1995, p. 248)

Demographic estimates

To estimate φ, *f*, and λ for the TRB and UARB combined, Pradel robust design mixture models (Pledger 2000, Pradel 1996) in Program MARK (White and Burnham 1999, p. S122–S123) will be used. Robust design models are based on the assumptions of: (1) population closed to additions and deletions across all secondary sampling occasions within a primary sampling session; (2) temporary emigration is either completely random, Markovian, or based on a temporary response to first capture; and (3) equal survival probability for all individuals, regardless of availability for capture (Kendall 2014, p. 13-15). Models will be fit and evaluated with Akaike's Information Criterion corrected for small sample size (AICc; Burnham and Anderson 2002, p. 374–380). All models ≤4 ΔAICc will be averaged according to the methods outlined in Burnham et al. (2011) to produce final, model-averaged parameter estimates. To estimate *N* for the TRC subpopulation, closed-population CMR models in Program MARK (White and Burnham 1999, p. S122–S123) will be employed. Closed-population models are based on the assumptions of: (1) demographic closure (i.e., no births, deaths, immigration, or emigration during sampling) and geographic closure; (2) animals do not lose their marks during sampling; (3) marks are recognized and recorded correctly; and (4) all animals have an equal opportunity of being captured during each sampling session. Models will be fit and evaluated with Akaike's Information Criterion corrected for small sample size (AICc; Burnham and Anderson 2002, p. 374–380). All models ≤4 ΔAICc will be averaged according to the methods outlined in Burnham et al. (2011) to produce final, model-averaged parameter estimates. The exponential growth equation from Gotelli (2008) will be used to estimate λ between 2014 and 2019 at TRC.

To estimate *S* for the TRB, UARB, TRC, and LARB, known-fate survival models in Program MARK will be used (White and Burnham 1999, p. S122–S123). Bears that shed their collars (i.e., leather spacer broke or collar slipped off bear) will be assumed alive at the time of last active signal and right censored to the sampling occasion of the last active signal. Bears that are not encountered during >2 consecutive sampling occasions, but were re-encountered will be right censored to the sampling occasion of the last active signal and re-entered in the dataset as a new individual when it was re-encountered (Laufenberg 2014, p. 17). Models will be evaluated using Akaike's Information Criterion corrected for small sample size (AICc; Burnham and Anderson 2002, p. 374–380).

To estimate recruitment (*f*) from live-capture data and den checks for the TRB, UARB, TRC, and LARB, a Pradel estimator will be used (Pradel 1996) in Program MARK (White and Burnham 1999, p. S122–S123). Models will be evaluated using Akaike's Information Criterion corrected for small sample size (AICc; Burnham and Anderson 2002, p. 374–380). To investigate temporal trends in litter size, linear mixed models with random effects will be used . Litter size will be modeled with and without time effects, intra-bear correlation will be accounted for using a random intercept for individual mother, and the models will be compared using Akaike's Information Criterion corrected for small sample size (AICc; Burnham and Anderson 2002, p. 374–380).

D. Practices to Assure Consistency of Data Collection

Population and habitat monitoring methods are deliberately using the same protocols as those used during the species' recovery. This will ensure data collection and analysis consistency, and allow comparisons to previous years' data which will also result in more accurate estimates of natural variability. The following practices will be followed in order to minimize variability that could be introduced by inconsistent sampling practices:

1. LDWF will be the primary entity conducting the PDM and employs multiple staff members that have conducted recovery monitoring and are familiar with locations and sampling procedures.

2. Biologists and technicians will be properly trained in the needs and life history of the Louisiana black bear and in the implementation of the mark-recapture hair snare stations by LDWF bear program personnel.

3. DNA analyses will be conducted by approved laboratories that have their own quality control standards.

4. Population monitoring and analyses will be conducted under similar temporal and spatial conditions (see Section VI.A), using the same methodology and in a manner consistent with prior years' recovery monitoring.

5. Habitat trends analyses will be conducted using comparable methods over time. Metadata will be obtained with any digital data that is used for these analyses and created by other agencies. Metadata will be generated for any digital data layers that are created as part of the post-delisting monitoring.

6. Annual population reports will be submitted to the Service's Louisiana Ecological Services Field Office by LDWF. The Service will provide annual habitat summaries to LDWF. Both agencies will meet annually to jointly evaluate the report results and to discuss and develop any needed adjustments.

E. Frequency and Duration of Monitoring

The PDM period will be initiated during the first spring following the publication of a final rule to delist the Louisiana black bear and will extend, at a minimum, through the 7th spring following delisting. Specific monitoring requirements are specified in Section III.B – C above. The LDWF will be the primary agency responsible for PDM of the TRB, UARB, LARB, and TRC populations; however, some monitoring may be contracted to a USGS or other research partner. Frequency of population monitoring is described in Section VI.A and Table 1. Habitat monitoring frequency is described in Section VI.B and is dependent upon the availability of digital products created by other agencies (Table 1).

VII. Definition of Response Triggers for Potential Monitoring Outcomes

Effective PDM requires timely evaluation of data and responsiveness to observed trends. In order to assure timely response to observed trends, it is necessary to identify possible outcomes from monitoring that could be anticipated and general approaches for responding to these scenarios. To identify thresholds that would trigger alternative responses in the case of the Louisiana black bear, it will be necessary to analyze data from the recovery monitoring period to identify the range of variability that has been observed with respect to each of the variables that will be monitored during the PDM period.

To ensure that the most reliable population demographic measure will be used for post-delisting monitoring, a sensitivity analysis is currently being conducted by USGS (Appendix 1). That analysis will be used to directly calculate the relative importance of demographic rates to population growth rate and other population-level statistics (Caswell 2001) and to population persistence based on methods used in Laufenberg et al. (2013). Decision thresholds identified by that analysis could then be used in conjunction with statistical power analyses to explore alternative study designs and data collection options for further improving or refining post-delisting monitoring protocols. From these analyses, it will be possible to categorize observations into one of the following three possible PDMP outcomes:

A. Category I

Louisiana black bear metapopulation remains secure without ESA protections. This would be true if:

1. Female survival (S), and per-capita recruitment (f), observed from radio-collar data, annual den checks, and mark-recapture efforts, remains within the 95th percentile[1] of values observed since monitoring for this species began in 2006;
2. The amount of forested habitat supporting breeding subpopulations and areas between subpopulations (based on the NAIP imagery) within the HRPA remains

stable, increases or does not decrease more than 5 percent from the baseline (2013) estimates;
3. No new or increasing threats to the species are observed.

In this case, PDM would be concluded at the end of the timeframe specified in this Plan.

B. Category II

<u>Louisiana black bear metapopulation or habitat may be less stable than anticipated at the time of delisting, but information does not indicate that the species meets the definition of threatened or endangered</u>. This would be true if:

1. Female survival (*S*), and per-capita recruitment (*f*), observed from radio-collar data, annual den checks, and mark-recapture efforts, remains within the 95th percentile[1] of values observed since monitoring for this species began in 2006.
2. The amount of forested habitat supporting breeding subpopulations and areas between subpopulations (based on the NAIP imagery) within the HRPA declines range from 7 to 5 percent from the baseline (2013) on multiple sampling grids estimates; and

3. There are no new or increasing threats that are considered to be of a magnitude and imminence that may threaten the continued existence of the Louisiana black bear within the foreseeable future.

In this case, existing data on subpopulation demographics (e.g., population rate-of-change [λ], apparent survival [φ], per-capita recruitment [*f*], survival [*S*], and mortality) and/or habitats (e.g., forested habitat mapping and ground-truthing, CWA permitted activities, trends in agricultural conversion) will be analyzed to determine the potential causes of those changes (e.g., normal timber harvest versus permanent conversion) and if any management interventions are needed or are available that would be expected to reverse declines and stabilize or improve trends.

C. Category III

<u>PDM yields substantial information indicating that threats are causing a decline in the status of the Louisiana black bear since the time of delisting, such that listing the species as threatened or endangered may be warranted</u>. This would be true if:

1. Female survival (*S*), and per-capita recruitment (*f*), observed from radio-collar data, annual den checks, and mark-recapture efforts, falls below the 95th percentile[1] of values observed since monitoring for this species began in 2006, for 3 consecutive years; and,
2. The estimated population viability (i.e., TRB, UARB, and TRC combined) is <90% persistence for 100 years; or

3. The amount of forested habitat supporting breeding subpopulations and areas between subpopulations (based on the NAIP imagery) within the HRPA has successive declines by greater than 7 percent on multiple sampling grids; or

4. There are new or increasing threats that are considered to be of a magnitude and imminence that they could threaten the continued existence of the Louisiana black bear within the foreseeable future.

If only the first two these conditions are true, then the Service should initiate a formal status review to assess changes in threats to the species to determine whether a proposal for relisting is appropriate. If all of these conditions are true, then the Service should promptly propose that the Louisiana black bear be relisted under the Act in accordance with procedures in section 4.

[1]This may be adjusted based on the results of the sensitivity analyses in order to achieve the best accuracy.

VIII. Data Compilation and Reporting Procedures

Annual reports summarizing the PDM activities accomplished, data collected, and results will be submitted to the Service's Louisiana Ecological Services Field Office by the LDWF. These reports should be prepared in a timely manner in accordance with this Plan to ensure that adequate data are being collected, to allow evaluation of the efficacy of the monitoring program, and to provide a periodic assessment of the status of the Louisiana black bear. Each annual report will synthesize all the population monitoring data and comment on observed trends and status of the Louisiana black bear with respect to the PDM outcome categories presented in Section IV of this Plan. Annual reports are due by December 30 of each calendar year and will include all data collected since October 1 of the prior year (one fiscal year).

After 7 years of data are available, the field collection data will be reviewed to determine overall population change and status with respect to threats. We will compile the annual report data into a final monitoring report that will be made available to the public. The final monitoring report will summarize the data in the annual reports. It will include a description of the geographic areas surveyed, the survey protocol, and updated population numbers for each locality surveyed.

If the response triggers in Section IV above are met or exceeded, the Service will consult with the LDWF, and other partners (USGS, MDFPW) to determine whether to conclude the PDM process or to pursue alternative actions as described in Section IV. Our determination also will include, if necessary, an evaluation of the threats to Louisiana black bear using the five factors required under the Act to list a species on the Federal List of Threatened and Endangered Wildlife and Plants.

IX. Estimated Funding Requirements and Sources

Post-delisting monitoring is a cooperative effort among the Service; State agencies, Tribes, and other Federal agencies, universities; and other non-governmental partners under the Act. Although the Act authorizes expenditures of both recovery funds and section 6 grants to the States to plan and implement PDM, Congress has not allocated or earmarked any special funds for this purpose. To the extent feasible, the Service intends to provide funding for PDM efforts from annual Endangered Species Recovery Program appropriations. Nonetheless, nothing in this Plan should be construed as a commitment or requirement that any Federal agency obligate or pay funds in contravention of the Anti-Deficiency Act (31 U.S.C. 1341) or any other law or regulation.

The primary entity conducting the PDM and preparing reports will be the LDWF, who has accomplished most of the recovery monitoring for the Louisiana black bear. Based on LDWF costs associated with recovery monitoring efforts, annual PDM expenditures for LDWF should not exceed $174,750. In 2019 LDWF costs should not exceed $203,750, which includes hair-sampling the TRC and the corridor connecting it to the TRB. The Service will provide assistance as needed and as resources permit, and will conduct the habitat analysis that is planned for the 7 years after delisting. Annual costs to the Service should be more for PDM years 2, 4, and 5 (due to habitat mapping and image analysis) but should not exceed $48,000 in years 1, 3, and 6, and $62,000 in each of years 2, 4,and 6, and in 2019 should not exceed $74,000 during year seven.

X. PDM Implementation Schedule

This schedule will be developed in coordination with the LDWF in order to ensure that it is feasible to accomplish PDM activities at all sites scheduled for a given year. The schedule will appear in the final Post-Delisting Monitoring Plan for the Louisiana black bear when it is published (Table 1).

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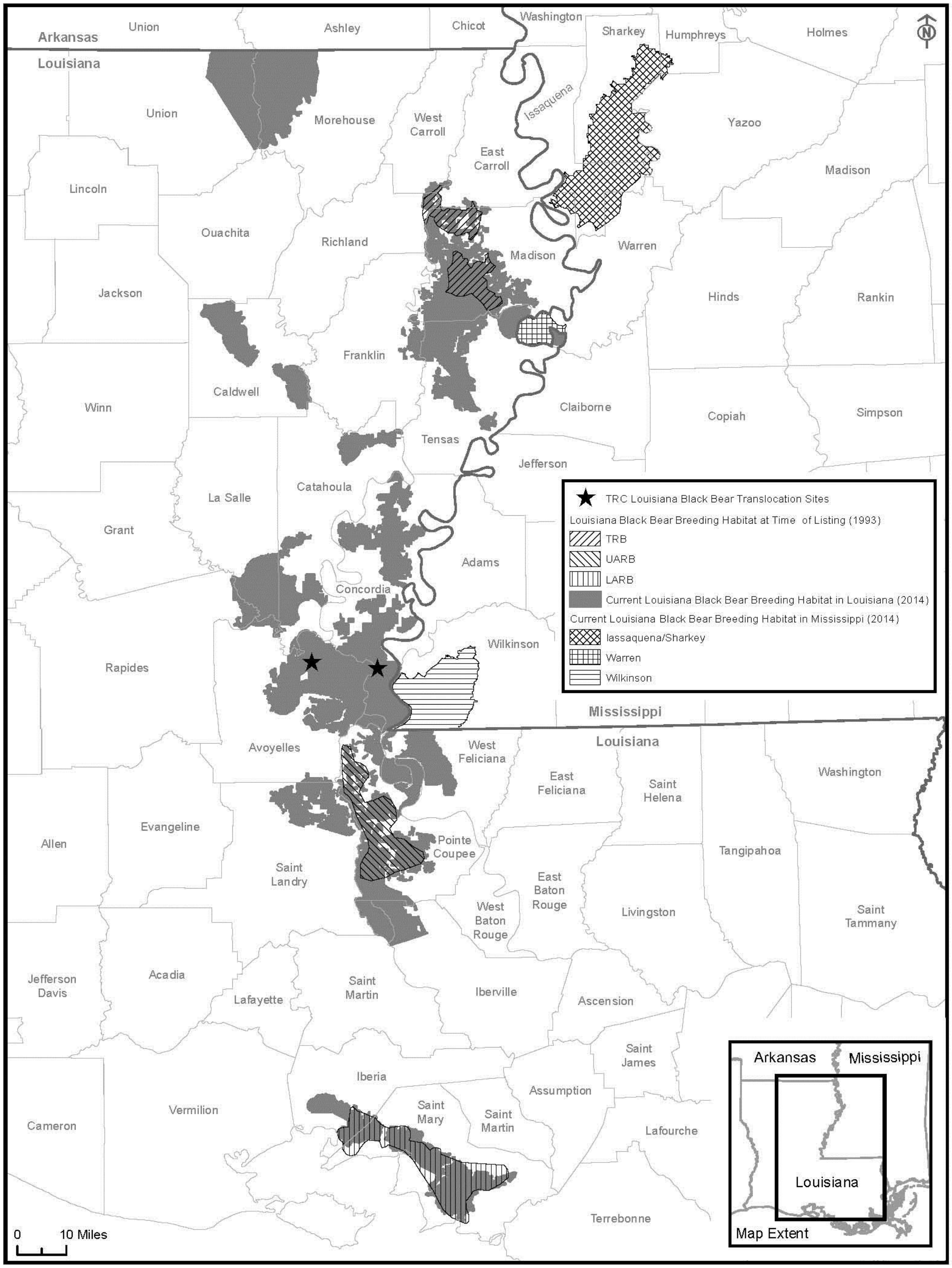
Figure 1. Map of Louisiana black bear breeding habitat at the time of listing (1992) and currently (2014) in Louisiana and Mississippi.



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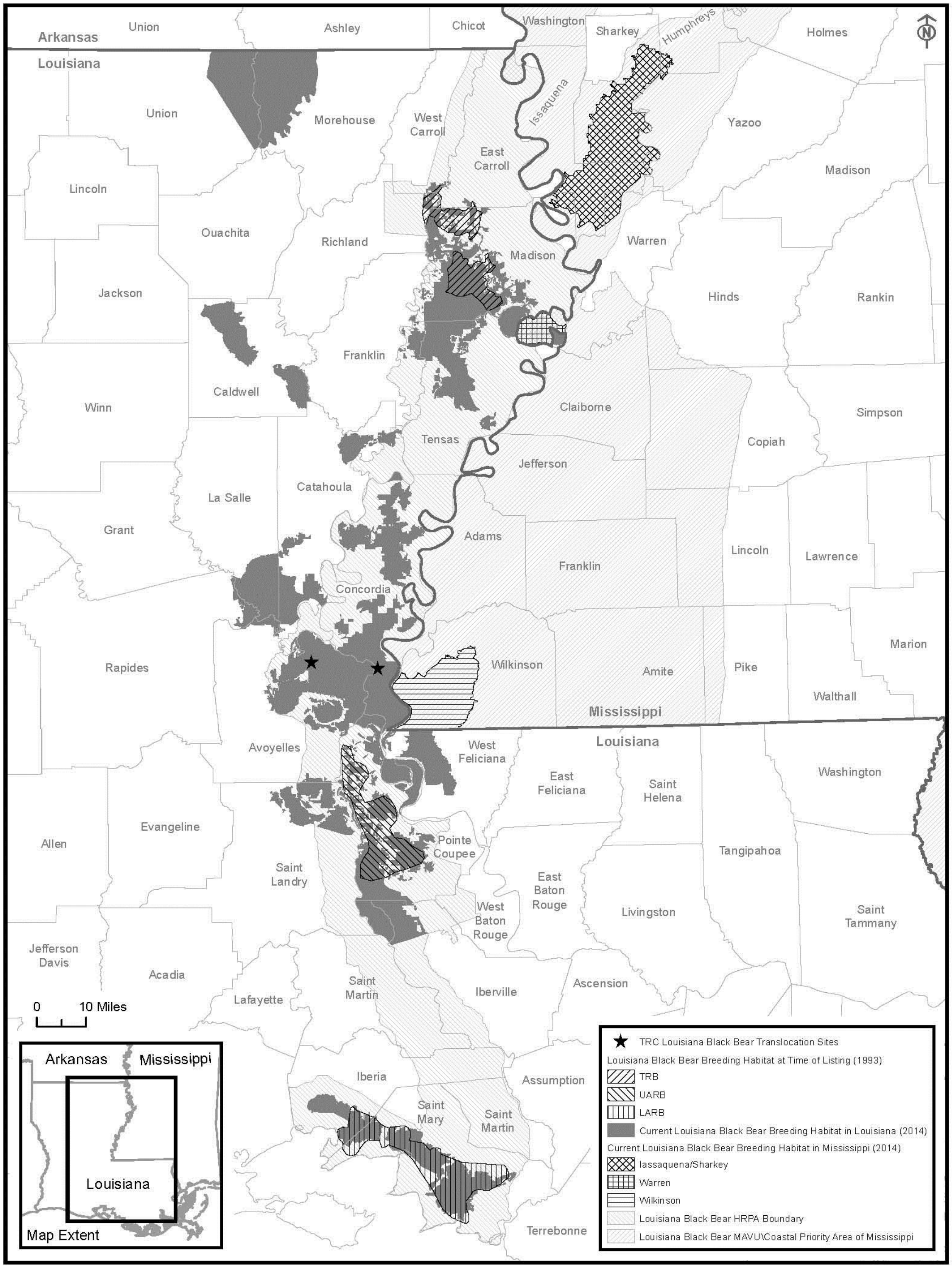

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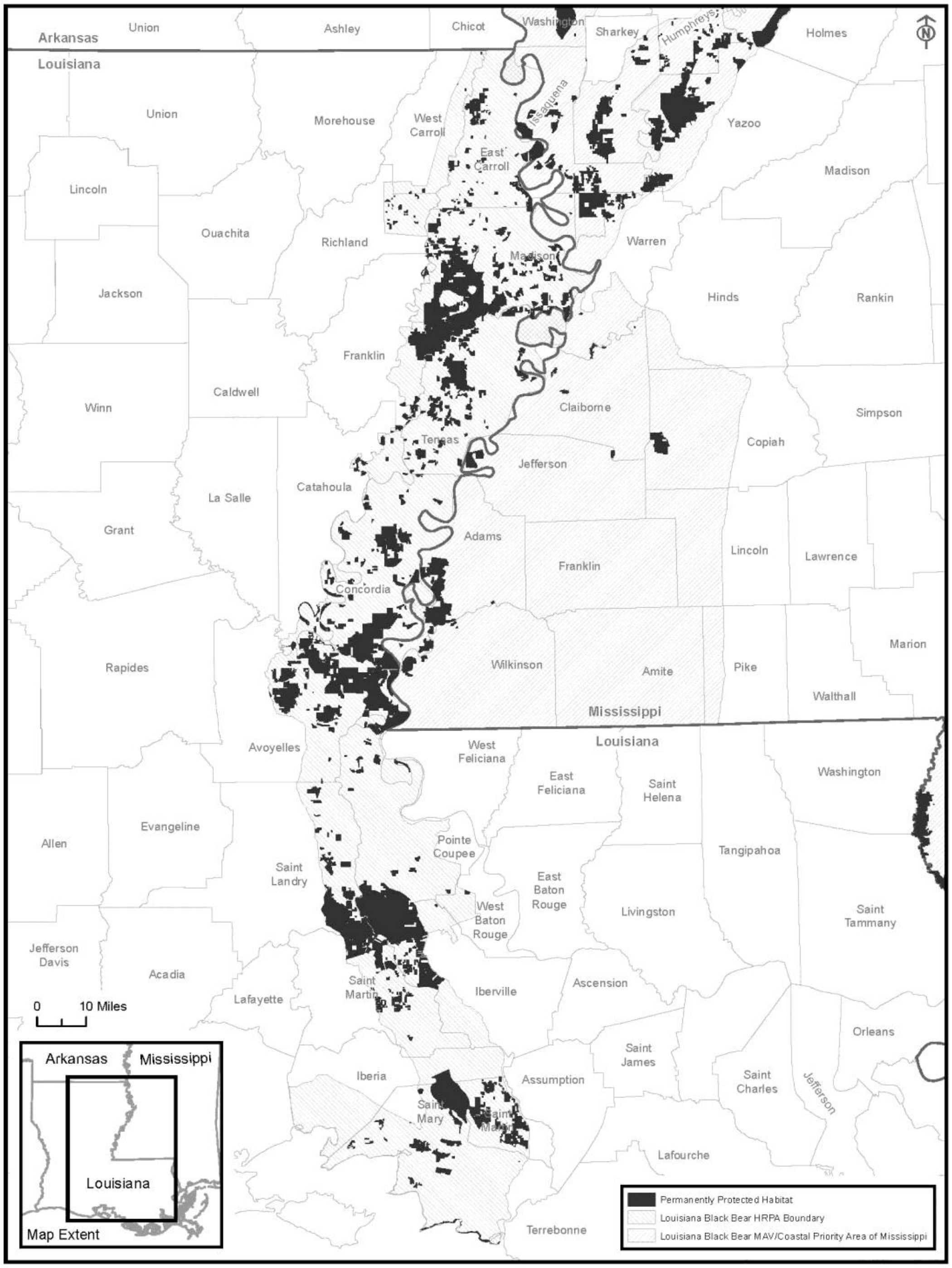

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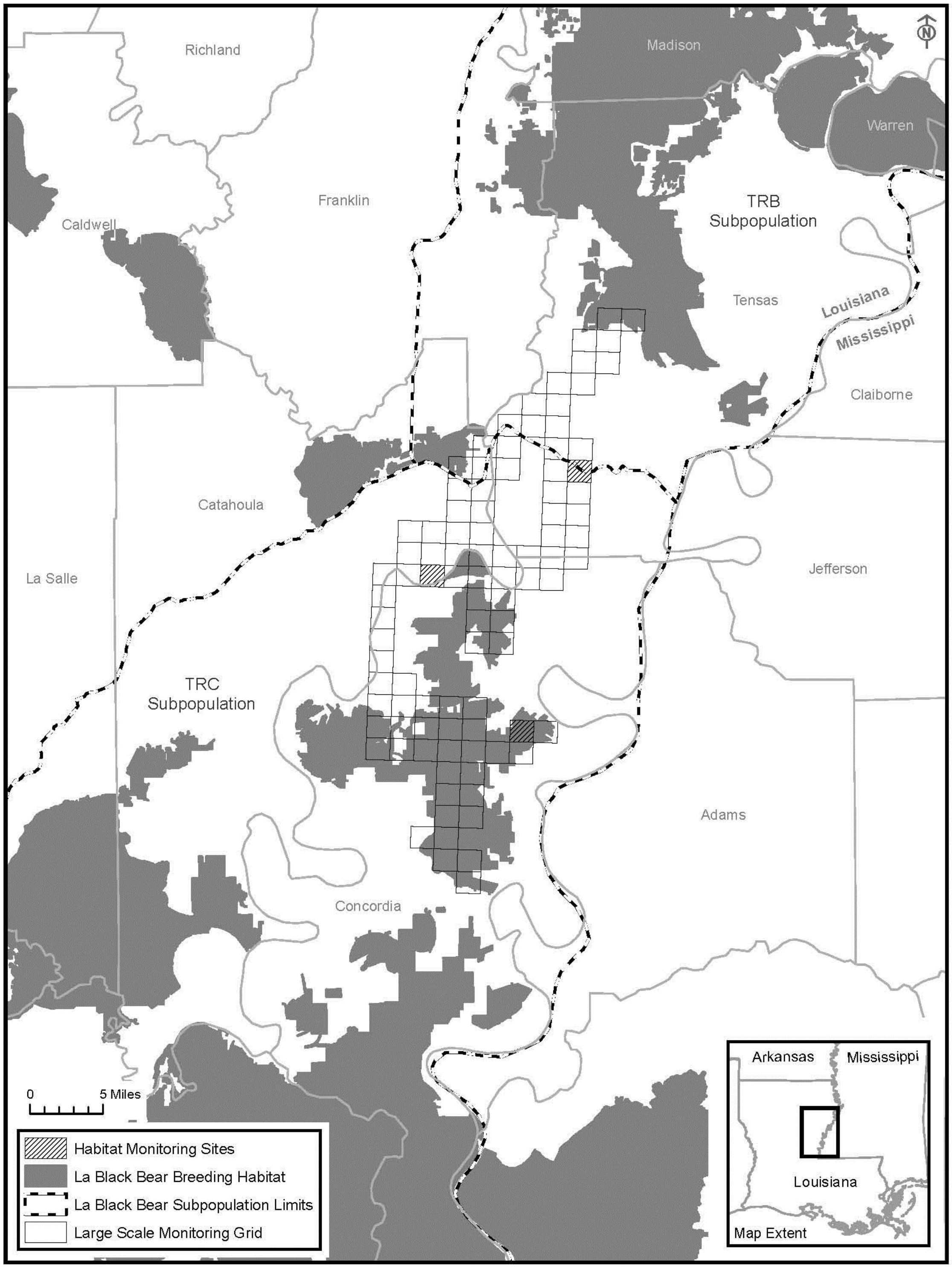

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Table 1. Timeline for Louisiana black bear post-delisting monitoring activities.

Monitoring Action		Year 1 (2015)	Year 2 (2016)	Year 3 (2017)	Year 4 (2018)	Year 5 (2019)	Year 6 (2020)	Year 7 (2021)	2022
Population Monitoring (LDWF)	Hair Snare *(TRB & UARB)*	X	X	X	X	X	X	X	
	Hair Snare *(TRC& Corridor)*					X			
	Live Trapping *(TRB,UARB,TRC,LARB)*	X	X	X	X	X	X	X	
	Den Checks *(TRB, UARB, TRC, LARB)*	X	X	X	X	X	X	X	
Population Connectivity (LDWF)	Live Trapping *(TRC and Corridor -start 2014)*	X	X	X	X	X	X	X	
	Genetics Analysis	X				X			Final Report
Habitat Monitoring (USFWS)	NAIP[1]		X			X			
	NLCD[2]				X				
	Protected lands, CropScape data collection	X	X	X	X	X	X	X	
Data Analyses		X[3]	X	X	X	X	X	X	
Interim Reporting			X	X	X	X	X	X	

[1]Baseline NAIP imagery is 2013
[2]2016 NLCD imagery

Table 2. Estimated area supporting Louisiana black bear breeding subpopulations (ac[ha]) in 1993 and 2014.

Breeding Habitat	Tensas River Basin[1]	Upper Atchafalaya River Basin[2,]	Lower Atchafalaya River Basin[3]	Louisiana Total	Mississippi Total[3]	Total
1993	84,402 [34,156]	111,275 [45,031]	144,803 [58,600]	340,480 [137,787]	0	340,480 [137,787]
2014	1,002,750 [405,798]	290,263 [117,465]	130,839 [52,949]	1,423,853 [576,213]	382,703 [154,875]	1,806,556 [731,087]

[1] Includes the TRC subpopulation and the Louisiana black bear subpopulation in north-central Louisiana near the Arkansas state line.
[2] Includes the Louisiana black bear subpopulation found in the Florida parishes of Louisiana (east of the Mississippi River).

Table 3. Private lands enrolled in the USDA Natural Resource Conservation Wetland Reserve Program (permanent easements) (ac[ha]) supporting breeding habitat and within the Louisiana Black Bear Habitat Restoration Planning Areas, Louisiana.

	Tensas River Basin[1]	Upper Atchafalaya River Basin	Lower Atchafalaya River Basin	Total
Breeding Habitat[2]	90,198 [36,502]	6,500 [2,630]	0 0	96,698 [39,132]
HRPA	136,870 [55,389]	11,530 [4,666]	0 0	148,400 [60,055]

[1] Includes the TRC subpopulation.
[2] Breeding habitat is primarily contained within the HRPA, but has expanded beyond it in some areas..

Table 4. Total area (NWRs, WMAs, WRPs, Corps lands, Farmers Home Administration [FmHA] Easement tracts, and wetland mitigation banks) (ac[ha]) within Louisiana Black Bear Breeding Habitat and the Louisiana Black Bear HRPA, within Louisiana.

	Tensas River Basin[1]	Upper Atchafalaya River Basin[3]	Lower Atchafalaya River Basin[3]	Total[3]
Louisiana black bear breeding habitat	1,002,750 [405,799]	290,263 [117,465]	130,839 [52,949]	1,423,853 [576,213]
Permanently protected Louisiana black bear breeding habitat[2]	493,639 [199,769]	91,880 [37,182]	7,614 [3,081]	593,133 [240,032]
Percent of Louisiana black bear Breeding Habitat that is permanently protected[2]	49.2	31.7	5.8	41.7
Louisiana black bear HRPA	2,054,811 [831,553]	1,200,844 [485,964]	366,001 [148,115]	3,621,656 [1,465,632]
Permanently protected habitat within the Louisiana black bear HRPA	408,400 [165,274]	217,936 [88,195]	11,573 [4,683]	637,909 [258,152]
Percent of the Louisiana black bear HRPA that is permanently protected	19.9	18.1	3.2	17.6

[1] Includes the TRC subpopulation.
[2] Breeding habitat is primarily contained within the HRPA but has expanded beyond it in some areas.
[3] Figures shown in this table are based on currently available spatial data and represent the most accurate estimates to date. Certain protected habitat estimations presented here are lower than the figures provided in the Louisiana black bear 5-Year status review document due to improved data availability and associated methodology, and not to actual reductions in protected habitat.

Table 5. CRP within the Louisiana Black Bear Breeding Habitat and Louisiana Black Bear Habitat Restoration Planning Areas, Louisiana (ac[ha]) (Numbers may not total due to rounding).

	Tensas River Basin[1]	Upper Atchafalaya River Basin	Lower Atchafalaya River Basin	Total
Breeding Habitat[2,3]	44,766 [18,116]	21,770 [8,810]	0 [0]	66,536 [26,926]
HRPA	120,793 [48,883]	1,344 [544]	11 [5]	122,149 [49,432]

[1] Includes the TRC subpopulation.
[2] Breeding habitat area is largely a subset of (i.e., contained within) the total HRPA.
[3] Breeding habitat areas have expanded beyond the HRPA boundary.

Table 6. State and Federal management areas within the Louisiana Black Bear Habitat Restoration Planning Areas, Louisiana (ac [ha]) (Numbers may not total due to rounding).

	Tensas River Basin[1,2]	Upper Atchafalaya River Basin[2]	Lower Atchafalaya River Basin[2]	Total[2]
NWRs	111,966 [45,311]	17,614 [7,128]	7,426 [3,005]	137,006 [55,444]
WMAs	143,933 [58,248]	59,423 [24,048]	1,474 [597]	204,830 [82,892]
Atchafalaya Basin Floodway Master Plan Easements and Acquisitions[3]	-	126,417 [51,159]	-	126,417 [51,159]
Total	255,899 [103,559]	226,037 [91,476]	8,900 [3,602]	480,836 [194,588]

[1] Includes the TRC subpopulation.

[2] Some acreage figures are less than that presented in the Louisiana black bear 5-Year Status Review due to property boundary refinements and corrections for certain NWRs and WMAs.

[3] This acreage (126,417) does not equal the 141,400 ac estimated by the Corps (Lacoste 2014). The reason for the apparent discrepancy is that the LDWF has been granted management authority over portions of the 141,400 ac (which include both fee title and easement properties). In our analysis, the management-transfer acreage was credited to LDWF (in the form of WMA acreage) rather than to the Corps. However, the total calculated protected-habitat acreage remains consistent (and accurate) regardless of that management authority reassignment.

Table 7. Federal and State natural resource management areas (ac[ha]) containing habitat that supports Louisiana black bear breeding subpopulations.

	Tensas River Basin[1]	Upper Atchafalaya River Basin[2,3]	Lower Atchafalaya River Basin	Louisiana Total	Mississippi Total[4]	Total
NWRs	160,815 [65,079]	16,030 [6,487]	7,355 [2,976]	184,199 [74,543]	4,383 [1,774]	188,582 [76,316]
WMAs	223,926 [90620]	49,042 [19,846]	0	272,968 [110,466]	0	272,968 [110,466]
Total	384,741 [155,699]	65,071 [26,333]	7,355 [2,976]	457,167 [185,009]	4,383 [1,774]	461,550 [186,783]

[1] Includes the TRC subpopulation and the Louisiana black bear subpopulation in north-central Louisiana near the Arkansas state line.

[2] Includes the Louisiana black bear subpopulation found in the Florida parishes of Louisiana (east of the Mississippi River).

[3] These figures do not include Atchafalaya Basin Floodway Master Plan easements and acquisitions purchased by the Corps, or lands not managed as part of a Federal or State natural resource management area.

[4] Although there are Louisiana black bear breeding subpopulations in Warren, Wilkinson, Issaqueena, and Sharkey Counties, only the Issaqueena\Sharkey subpopulation is currently located by State and Federal lands.

Appendices

Appendix 1. Sensitivity Analysis Methodology To Determine Appropriate Variables and Decision Categories for Post-delisting Monitoring.

Sensitivity and elasticity analyses based on deterministic matrix population models are commonly used to directly calculate the relative importance of demographic rates to population growth rate and other population-level statistics (Caswell 2001). McCarthy et al. (1995) combined population simulation methods and logistic regression to determine relationships between demographic rates and extinction probabilities and those rates to which extinction risk is most sensitive while incorporating environmental stochasticity and density dependence and accounting for nonlinearities and interaction effects. This approach involves randomly generating a value for each demographic rate of a population model from specified probability distributions and then using that model to simulate a population trajectory over a period of time. That process is repeated numerous times with the end abundance (N_{end}) for each iteration summarized as a 1 for extinct (i.e., $N_{\mathrm{end}} = 0$ or other quasi-extinction level) or as a 0 otherwise. Logistic regression is then used to fit a set of models including all possible combinations of independent variables where the summary outcomes and the demographic rate values for each iteration are the dependent variable and independent variables, respectively. Higher-order polynomials can also be included to test for nonlinearities and products of independent variables can be used to test for interactions.

Importance of each demographic rate can then be determined through variable selection routines based on criteria such as Akaike's Information Criterion (AIC; Burnham and Anderson 2002). Relative importance of each demographic rate can be evaluated by calculating the difference in AIC (ΔAIC) between the global model and the corresponding reduced model that excluded model terms involving the specified demographic rate (Laufenberg et al. 2013). Demographic rates can then be ranked in ascending order based on the size of the corresponding ΔAIC value with higher ranked rates representing rates more important to extinction risk.

The logistic regression-based sensitivity analysis approach will be used in combination with demographic rate estimates and population projections models from Laufenberg and Clark (2014) to estimate functional relationships between demographic rates and extinction risk and demographic rate thresholds beyond which extinction probabilities exceed acceptable levels (i.e., decision thresholds). Relative importance of demographic rates to population persistence will be determined based on methods used in Laufenberg et al. (2013). Additionally, work is ongoing to combine stochastic population simulations with logistic regression and classification tree analyses to evaluate the importance of demographic rates to extinction risk and to identify demographic thresholds that are reliable indicators of potential population extinction for the TRB and UARB subpopulations (Laufenberg et al. 2015).